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# The International Journal of Orthodontia Oral Surgery and Radiography

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Editor

Martin Dewey, D.D.S., M.D., F.A.C.D., New York

H. C. Pollock, D.D.S., St. Louis, Associate Editor

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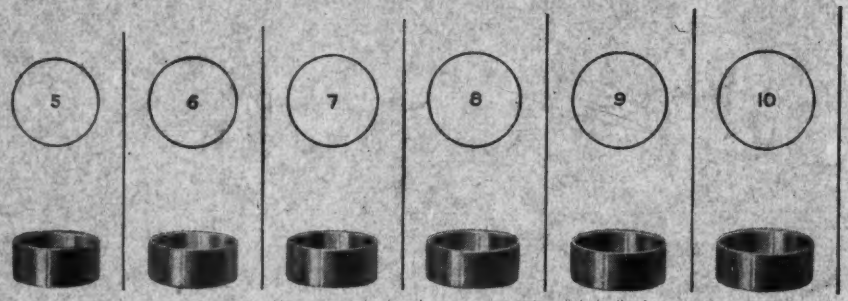


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## ORIGINAL ARTICLES

### PHYSICAL CONSIDERATIONS CONCERNING THE ALLEGED STABILITY OF BONES, TEETH AND SIMILAR STRUCTURES*

BY SAMUEL E. POND, PH.D., PHILADELPHIA

WE SHALL turn our attention to certain factors related to calcification and upon which the stability of bone and similar structures is presumed to depend. Many of the diseases of bones and some of the causes of destruction of teeth have been laid to the absence of one chemical substance or another just as often as to a definite attacking agent (such as bacterium, acid, or toxin). But there is a too one-sided picture in most of our minds when we consider bones, teeth and similar structures. We are prone to explain our difficulties away on the basis of a very general idea which in turn has been developed from a point of view altogether too restricted in scope. As there are two sides to most every tale, there are two general methods of attacking the problems involved in calcification. The growth of bones, teeth, and shells is similarly dependent upon the activities of living cells and tissues but curiously we have worked in a backward direction in ascertaining the facts concerned with such development. It seems to me that we have overemphasized analytical data taken from various experiments and particularly those from experiments in which the calcareous structures are destroyed. Investigations have yet to be systematically made of the physical characteristics of those bone-like masses upon which the body variously depends for support, protection or certain minerals. And, furthermore, we need to know what elements underlie the structure, not in the sense of what chemicals and cells enter into its composition but how they are related physically as well as chemically. Analytical methods will not alone provide us with a clear picture. We must watch these structures grow and compare them from time to time during their growth with nonvital phenomena so that we may explain the developmental steps.

*Read before the Annual Meeting of the Alumni Society of the Dewey School of Orthodontia, New York City, August 29, 30, 31, 1927.

As concerns the growth of bone particularly, we are too dependent upon the knowledge gained from analytical chemistry and histology. Now it is essential to analyze bones to determine their chemical content; and it is likewise profitable to section the normal and diseased bones to ascertain certain facts concerning the structures, or changes in the structures, occasioned by disease. But chemical analyses are sometimes hard to interpret; and the histologic method introduces problems of its own which are related to the methods of fixation and hardening. If we attempt to gain from analytical chemical data or from histologic sections a picture of the underlying processes in ossification we are lost. This fact has been appreciated before. This criticism is brought to your attention because some of the details of this paper are taken from experiments which have been carried out along lines with which you are probably not as familiar as those of chemistry and histology and you may ask the reason for the different attack upon this very old problem. This paper is but another approach to more or less fundamental questions concerning calcification although chiefly is concerned with certain physical and chemical changes in bones and shells. The aim is to ascertain the factors underlying the stability of bones and teeth and also to test the hypothesis that calcium phosphate is the most stable element, an hypothesis implied by many students of the problem in their published reports.

The consideration of bones from the anatomic point of view has so warped our mental picture that I believe we need to provide ourselves with other facts more suitable. Form and shape are important to consider in certain instances, but not in others. Bones taken from the anatomic collections for study and dried bones used for analysis by chemical or histologic methods are too often considered without respect to age or marrow content. Much experimental work assumes that bones arise through certain well-established chemical reactions and tend only in one direction. One realizes, however, from a reconsideration of the anatomic data, that the development of bone is not a simple process and it is not unidirectional. Compositional as well as structural changes in bones appear to be related to change in function and this fact should direct our attention to the importance of the reciprocal relation between function and structure. The study of old bones is limited in its value and particularly is this true when we search for the structural and compositional elements which suffer alteration with changes in function and advancing age.

Similarly, the concept of bone formation from the standpoint of chemical analysis is a limited one. While we do not know whether the blood bathes the bones directly, we do know that there is a tide of calcium and phosphate and bicarbonate in the blood which is affected by the supply of these elements in the bones. Calcium and phosphate both serve other important functions than making bone. But the point here emphasized is that an analysis of bone does not indicate how the chemical elements go to make up the structure nor does analysis direct us to the changes in bones and teeth.

The contributions to the subject of ossification from both anatomy and chemistry have thus tended away from an all-around picture and have not indicated the dependent relationships which have great biologic significance.

We have, in the past, been accustomed to conclude that, provided the osteoblasts receive suitable nourishment from the blood stream, their growth and their additions to the bony structure will proceed to certain well-defined limits. The reciprocal relation of the bones to the body as a whole has not been suitably appreciated. We have studied the bones for their more apparent structural elements. We have but recently learned that the changes in hardness, volume and density of bone do not uniformly follow increase in age nor in one direction; and we have yet to appreciate that these calcareous tissues change within themselves quite independently of the cells which formed them, as for example those changes in the enamel of teeth, and the shells of molluscs which have become dissociated from the original ameloblasts. Studies of metabolism have indicated that the bones are incessantly tapped for calcium by other tissues of the body and that the bony structure is being altered during health as well as during disease. We have long known that compact bone is giving way to trabecular bone in certain areas. All these changes and other apparent ones are but an index of the sublime alterations of structure and composition; hence we may state that bone, as it fits into the scheme of the body economy, is a functional mass, in a state of flux, quite dependent upon its functions and the functions of associated tissues.

We must also consider bone as a growing tissue and view it in the light of elementary biologic concepts. Bone, and we can well include dentine and cementum, is a slowly but continually changing mass in a state of apparent equilibrium with the adjacent tissues and the blood. This apparent equilibrium or balance involves both a physical and chemical aspect. The essential chemical factors involved in ossification or calcification serve as basic elements upon which the physical characteristics of the structure depend. But unless there is a hardened mass of calcium salts there is no real stability in bones and teeth; that is, calcium salts in liquids, in gelatine or even in cartilage are not stable structures, for they will not support any considerable stress. Furthermore, if they were unorganized precipitates, low calcium concentration in the blood alone would directly reduce the stability of the calcified structures since it upsets the apparent balance or equilibrium and permits the chemical changes to proceed toward a solution of the constituents. In other words a reversal in the order of the usual chemical reactions would affect the physical characteristics. Only when some substance is formed as is suggested through the synthesis of a more basic and more stable substance than tricalcium phosphate (e.g., oxyapatite) could we postulate an irreversible chain of events. While this is possible, as we shall point out, there are other factors which involve the hardening process. Experimental work indicates some physical processes such as crystallizations which are concurrent with increase in viscosity of calcifying masses and resemble the irreversible reactions like the setting of cements. These may depend upon sublime or very complicated chemical reactions of which we are ignorant. But a study of the changing physical characteristics with respect to growth and artificial stresses seems a fitting way of exposing significant factors underlying calcification.

The reasons for discussing at this time the synthesis of bone from a more or less physical angle are both practical and theoretical. First, we have a better basis of work. The underlying chemical literature to which we have access is of a dependable nature such as provides one with a good basis for a physical study. The researches on the solubilities of calcium carbonate and calcium phosphate under equilibrium conditions have recently been published by Holt, LaMer and Chown[1] and by Hastings, Murray and Sendroy.[2] Such work, together with the earlier studies by Bassett[3] on the phosphates of bone, etc., lead us from analytical to physical chemistry; from a study of what is in bone to an investigation of the process by which the stable structure in bone remains in existence and also how it comes into existence. Certain additional facts must now be searched out to carry this basic work on to a point where we may either explain away discrepancies in the literature concerning the proportions of carbonate and phosphate in bone or indicate what the true proportions are at different age levels and their significance. Second, some clinical methods may now be employed to check "in vitro" work. Outside of the experimental laboratory, the clinician in moving teeth and in making certain adjustments to correct malposition is affecting the physical structure by physical as well as vital means. His experiments and efforts may guide us in interpreting experimental results and thus provide a clearer statement of structural changes. The pediatrician is interested in attempts to secure stable bone in correcting rickets. Some clinical methods of this type have been employed in the laboratory and are of use in studying the growth of bones and teeth. Finally, suitable biologic methods are at hand. In some cases the application of pressure to tissues in the process of growth wherein the deposition of calcium is involved have shown that a delayed hardening and also a low grade of crystallization accompany such stresses. In the development of shells of some marine animals crystallization is detectable simultaneously with hardening of the mass although crystals are absent before, and they are constantly present after, setting.

## ELEMENTARY KNOWLEDGE OF THE FORMATION OF BONE AND SIMILAR STRUCTURES

From the chemical standpoint the primary bone salts are calcium carbonate, $CaCO_3$, and tricalcium phosphate, $Ca_3(PO_4)_2$. There is still some question whether the secondary calcium phosphate, $CaHPO_4$, exerts any influence upon the structure of bone or persists at all in stable bone. It is more customary to view the secondary phosphate as an unstable, transitory compound which is transformed in the bony matrix into the more soluble primary phosphate, $Ca(HPO_4)_2$, and the tricalcium phosphate, $Ca_3(PO_4)_2$. As more and more phosphate arises, the tendency is toward the tertiary and even more stable form, the oxyapatite, $Ca_3(PO_4)_2.Ca(OH)_2$. Generally speaking, we have considered the carbonate and phosphate to be concentrated simultaneously with the appearance of the osteoblasts, and there are indications of a physical or chemical combination of the organic matrix with the calcium ion and possibly also with the carbonate and phosphate ions. Now the combination of calcium with carbonate and of calcium with phosphate alone results in salts of relatively low solubility. But we are aware that the

*mere precipitation* into the tissues of calcium carbonate and calcium phosphate does not provide a structure similar in any essential respect to bone. One may add limewater to a phosphoric acid solution in a great variety of ways and the precipitate will rarely look, or feel or in other ways appear, like bone, teeth or shells. In this light there would appear to be some additional factor which must be taken into consideration. In certain regions of the body cartilage precedes bone. The cartilage cells disappear, however, as other cells (i.e., the osteoblasts) multiply and, along with the formation of blood vessels in the mass, there occur condensations and structural formations which ultimately lead to bone. One might conclude that the precipitation of the calcium salts in the cartilage would produce bone. But cartilage in solutions with excess of calcium carbonate and calcium phosphate have not indicated the appearance of any structure resembling bone. Now rachitic bone, which is not hard but which, in contrast to cartilage, has a vascular supply and is in other ways more like bone than cartilage, does not transform into hard bone when placed in solutions with excess of calcium carbonate and calcium phosphate. It is possible that, as the cartilage is transformed by the osteoblasts (and other agencies) the matrix provides a more or less chemical entity for some association with the elements of the bone salts, or more particularly, the active ions $Ca^{++}$, $(PO_4)^{=}$, $CO_3^{=}$. Certainly bone does not form by a mere physical precipitation into the organic matrix of calcium carbonate and calcium phosphate. It is also clear that many bones are formed without being preceded by a true cartilage, although a slime or protoplasmic mass arises in these cases before any bone is found. From this we presume that the actively proliferating cells form a slime or gelatinous mass and then along with cell development and the concentration of calcium salts the gel becomes transformed into a solid.

There are several physical characteristics of bone which are significant and some of these are intimated in the above elementary statement of the chemical and histologic origin of bone. We have indicated that some form of protoplasm precedes the calcification process proper. It appears as a slime, or a jelly. This semifluid mass is changed to bone through processes of which we are not yet certain. We are, however, aware of an increase in viscosity, and of an increase in optical density as well as other physical changes which are of significance. Among these changes is to be mentioned an increase in rigidity with appearance of crystallization in the mass with but very slight loss in resiliency. It is only with advanced age or disease that brittleness and loss of resiliency appear. The enamel of the teeth and shells exhibits crystalline form if cut in thin plates and may be studied with the aid of polarized light, as well as by the x-rays (i.e., in such a manner as to indicate the crystal form). The spicules* of the common sea urchin undergo hardening (or setting) subsequent to the appearance of crystals in the jelly-like mass. In the shell of most molluscs there are three layers, an outer or horny structure, a prismatic layer of greater rigidity than the rest, and a nacreous layer called "mother of pearl." Associated with the early formation of the prismatic layer one may observe (with the microscope) that strings and beads of jelly-

*A calcium carbonate structure associated with early development.

like material arise in close approximation to the mantle cells. With microscopic dissecting needles this mass may be as easily distorted and deformed as could any jelly. If masses of this substance are transferred from time to time to sea water and carefully observed, one notices that, while at first only a gelatinous, colloid mass is present, there later arise larger and larger aggregates which have some of the properties of crystals. Subsequently the mass is not easily distorted by dissecting needles and one finds it quite hard. In the small slipper-shell mollusc, Crepidula, one may watch the development of the shell gland and the growth of the shell. Here the early shell mass is gelatinous, but as growth proceeds it becomes a harder and more rigid structure. In all of these structures fine crystals are present at the time a hardened mass is first encountered; i.e., by manipulation of the living embryo. The hardened mass always shows crystal structure, while there is entire absence of crystal masses before the hardening is found to have occurred. We have thus concluded that in addition to a precipitation process there is some change involving crystallization associated with the hardening of the mass into a more rigid bone-like substance. This stage of calcification is not yet clearly worked out with respect to bone formation but it appears that the more physical processes such as crystallization, cementation and condensation are related.

## STABLE ELEMENTS OF BONE. OXYAPATITE

Of the primary bone salts, calcium carbonate and calcium phosphate, the latter is the more insoluble in water and on this ground might appear to be the more stable material comprising bone. A brief review of the ratio of the carbonate to phosphate in bones and teeth and of the relative solubilities of both the bone salts in organic media will, however, indicate the complexity of the subject and the difficulty of proving this point. It may also make clear that we cannot draw conclusions from simple experiments and certainly not alone from a study of aqueous solutions of the compounds. Furthermore a study of stability of the bone will be seen to rest on other grounds than merely the solubility of these two substances.

Analyses of bones by Gabriel,[4] Goto,[5] Hammett,[6] Wells,[7] Wildt,[8] and others indicate different proportions of Ca, Mg, P and of calcium carbonate, calcium and magnesium phosphate. Chemical analyses made from time to time have indicated that about 15 per cent of the inorganic part of bone was calcium carbonate, Wells (loc. cit.). There are, however, two aspects of the matter which lead to doubt that this is true. First of all, Wildt and others have cited the changing proportion of carbonate and phosphate as age increases.

Ash of rabbit's bones at different ages (from Wildt):

| | AT BIRTH | 1 MO. | 6 MO. | 1 YR. | 4 YR. |
|---|---|---|---|---|---|
| Ca phosphate | 86.04 | 85.87 | 84.47 | 82.45 | 82.25 |
| Ca carbonate | 8.30 | 9.09 | 11.23 | 12.98 | 12.86 |
| Mg phosphate | 3.01 | 2.66 | 2.29 | 1.99 | 1.81 |

This data indicates that the carbonate increases at the expense of phosphate, and that the usual ratio is from 9:86 to 13:82. Similarly pathologic calcifications and even rachitic bone approach this same ratio. In the absence of more careful studies of bones and teeth of the different ages, we cannot say whether this conclusion is justifiable or not. It also opens up the question of what variations in carbonate and phosphate occur with changing conditions of life and with especial respect to age. Certainly the ratios indicated are not definitely maximum nor constant and thus do not point to the presence of a definite carbonophosphate.

Hastings has recently pointed out[9] that the ratio of carbonate to phosphate is subject to correction. Calculating from Goto's data[5] the carbonate approaches 31 per cent and phosphate is consequently about 69 per cent. The reason for the differences in the ratio is of interest. In the older analyses the chemist has determined the phosphate concentration and the calcium and carbon-dioxide concentrations separately. On the assumption that the phosphate is all combined with calcium and that the balance of calcium is combined with carbon dioxide it is possible to get the lower calcium-carbonate values. Now, some of the phosphate comes from organic materials (e.g., marrow), and some is also known to exist in bone in the form of sodium and potassium phosphate. Obviously all of the phosphate may not be combined with calcium. Since the phosphate from organic sources cannot be avoided we may neglect this data and make the assumption that the carbon dioxide is combined with calcium. The balance of the calcium is presumably combined with phosphate. On this basis the calculation gives the higher figure for calcium carbonate; i.e., over 30 per cent. The actual ratio may, of course, lie between the two ratios indicated.

In solutions simulating blood, the precipitate of carbonate and phosphate has definite relation to the chemical concentration and to certain physical characteristics of the medium and any mass which develops from precipitation of the calcium salts can be altered by subsequent crystallization and condensation processes. If the development of the bones and teeth is shown to be accompanied by a gradual reduction in the phosphate as the data taken from Wildt (loc. cit.) tends to indicate, the physical and the structural factors may be related to postprecipitation changes and not alone to the most inactive phosphate (i.e., the oxyapatite). There are two different approaches which have to do with the study of structural characteristics and may be briefly indicated to illuminate the question.

We may study the physical characteristics of precipitated calcium salts and compare them with similar characteristics of bones and shells, taking into consideration the composition and states of development. In this way we may bring to light certain underlying factors upon which I believe the structural characteristics of calcified and ossified tissue depend. The comparison of the characteristics of precipitates in solutions of calcium salts with those of living calcified tissues will help us to understand some of the undisclosed processes in ossification and calcification. I shall refer briefly to the character of this experimental work and the general trend of the results.

Precipitates of calcium carbonate and phosphate are studied in solutions which simulate blood plasma both as to salt content and the presence of some colloid. A colloid is essential, otherwise some precipitation phenomena of significance are not observed. The experimental solutions which have been employed are of two types (a) phosphoric acid to which is added saturated limewater, $Ca(OH)_2$, and (b) solutions containing salts of sodium, NaCl, $NaHCO_3$, $Na_2HPO_4$, potassium, KCl, $KH_2PO_4$, $MgCl_2$, and magnesium, with and without carbon dioxide, to which is later added a calcium salt ($CaCl_2$). Either (a) or (b) may be made up with a colloid, such as gelatin, egg white, lecithin, gum mastic, or gum acacia. In (a) is formed chiefly calcium phosphate; in (b) chiefly calcium phosphate or mixtures of calcium phosphate and carbonate. The most prominent differences in the presence of the colloid are the increased time taken for the settling of the precipitate, the slower rate of crystal formation and also the more minute crystals.

If we consider those reactions which occur when the solutions are of similar hydrogen-ion concentration the characteristics of the precipitates are more comparable. In all cases it takes a certain amount of the lime to neutralize the phosphoric acid and to provide the tertiary (tricalcium) phosphate. This, of course, depends upon the dissociation of the phosphoric acid which may be indicated in the following way:

$$\text{I.} \qquad 2\ H_3PO_4 + Ca(OH)_2 \rightleftarrows Ca(H_2PO_4)_2 + 2\ H_2O$$

Here the phosphoric acid, $H_3PO_4$, is dissociated so that

$$H_3PO_4 \rightleftarrows H^+ + H_2PO_4^- \text{ and hence we may write the reaction}$$

$$\text{I.}\ 2\ (H^+) + 2\ (H_2PO_4)^- + Ca^{++} + 2\ (OH)^- \rightleftarrows Ca(H_2PO_4)_2 + 2\ H_2O$$

This indicates that in the early stage the precipitate is a monocalcium phosphate, $Ca(H_2PO_4)_2$. But as more limewater is added, the secondary $CaHPO_4$ and the tertiary phosphates, $Ca_3(PO_4)_2$, tend to be formed, viz.:

$$\text{II.} \qquad Ca(H_2PO_4)_2 + Ca(OH)_2 \rightleftarrows 2\ CaHPO_4 + 2\ H_2O$$

$$\text{Here the } H_2PO_4^- \rightleftarrows H^+ + HPO_4^=$$

$$\text{III.} \qquad 2\ CaHPO_4 + Ca(OH)_2 \rightleftarrows Ca_3(PO_4)_2 + 2\ H_2O$$

$$\text{wherein } HPO_4^= \rightleftarrows H + PO_4^=$$

In this way the acidity (depending upon the $(H)^+$ in solution) has been reduced and neutrality is approached. When such an amount of limewater has been added that reaction III has occurred there is present a precipitate of the tricalcium phosphate, $Ca_3(PO_4)_2$. The reaction depends upon the presence of the secondary phosphate, $CaHPO_4$. In solution it breaks up into (a) the monocalcium phosphate, and (b) the tertiary or tricalcium phosphate. If still more limewater is added we have the significant reaction giving rise to oxyapatite which Bassett has indicated[9] is the most stable phosphate of the bone salts:

$$\text{IV.} \qquad Ca_3(PO_4)_2 + Ca(OH)_2 \rightarrow Ca_3P_2O_8.Ca(OH)_2$$

This change occurs in the region near neutrality or slight alkalinity such as exists in the body fluids.

In other words a solution of the monocalcium phosphate (which provides no precipitate) reacts with lime to form the secondary phosphate (reaction I, page 376) and this breaks up in solution to provide the tri- and monocalcium phosphates. As more limewater is added the acidity lessens and the mono- and di- (i.e., secondary) calcium phosphates disappear from solution. The acidity is very slight when tricalcium phosphate is formed. Neutrality is reached and alkalinity approached as the more basic oxyapatite is formed in these solutions. The last reaction occurs at the expense of the tricalcium phosphate. At this stage the solution is, however, not necessarily more alkaline nor acid than is the blood and similar body fluids. Its $P_H$ is between 6.8 and 7.4. (This is the $P_H$ of vital significance.) As the basic oxyapatite is formed it presumably results in a reserve of material that subsequently does not enter into reactions with acids or alkalies over a considerable range of H-ion concentration. It is, in other words, not subject to change in the ordinary course of acidification; that is, it is unattacked in the course of ordinary physiologic reactions. In reaction IV the tricalcium phosphate is acted upon by the lime but it is subject also to changes in the presence of $CO_2$, and an increase in H-ion concentration (drop in $P_H$ value), viz.:

$$\text{V.} \qquad Ca_3(PO_4)_2 + 2\ H_2CO_3 \rightleftarrows 2\ CaHPO_4 + Ca(HCO_3)_2$$

so that the bicarbonate is formed. This is the tendency in the presence of carbon dioxide, a substance which is present in all biologic fluids and the concentration (or tension) of which is found to vary with metabolism.

In the experimental solutions the addition of $CO_2$ has been studied with a view to observing the change in crystal content as well as other factors. In all cases with solution (a), where limewater is added to phosphoric acid but without a colloid present, the precipitate is a loose friable mass which consists in regular crystals of the phosphates. The precipitate usually comprises mixtures of the secondary phosphate, $CaHPO_4$, and the tricalcium phosphate, $Ca_3(PO_4)_2$. The addition of $CO_2$ complicates the picture by the addition of mixed crystals of carbonates, etc. In the presence of colloids (particularly egg white and lecithin) the crystal masses develop extremely slowly and are very minute entities. The precipitates formed at chemical neutrality are not granular and friable but are viscous masses which may be agitated considerably without breaking up. These in time become semisolids, suggesting physical and chemical alterations in the mass. The precipitate approaches a waxy-like aggregate in the presence of the mother-liquor with apparent increase in density. The crystal patterns have been found to alter from time to time depending probably upon slow diffusion and chemical reactions. A chemical equilibrium is extremely slow to arise under these experimental conditions. In this respect there is some semblance of the conditions occurring in living tissues. Solutions of the type (b) where calcium chloride is added to sodium and potassium phosphate have the chief

difference that in the presence of carbon dioxide particularly the precipitates pass through a marked gelatinous stage on standing undisturbed in the presence or absence of a colloid, e.g., egg white or gelatine.

In the description of these experiments we should consider one factor, chiefly the rôle of the colloid. The $Ca^{++}$ ions and the $PO_4^{---}$ or $CO_3^{--}$ ions are surrounded by colloid particles which appear to inhibit certain chemical reactions, and the precipitates are thereby affected. Crystals form extremely slowly in such solutions where a substance like gelatine is present. The concentrations of certain ions in solution are also known to be increased in the presence of gelatine but each ion is apparently physically affected by the colloid particles. As far as crystallization is concerned, the mixture of a solution of calcium chloride and gelatine, added to a mixture of a solution of secondary sodium phosphate and gelatine slows the growth of the calcium phosphate crystals so much that in the first few minutes it is difficult to detect the presence of any. In twenty-four hours a solution will be found to contain extremely minute forms. If such a mixture of reagents is made that the resultant is a nearly neutral solution, the precipitation process is very long and drawn out. If other colloids are substituted for gelatine, a graded series may be arranged which exhibits progressive changes such as increase in viscosity of the solution, with swelling of the precipitate, condensation, and transformation of the mass of phosphate into a semisolid condition. The rate of condensation appears to be inversely proportional to the velocity of crystallization. If crystals are prevented in the first few hours by the concentration of the colloid, the mass slowly acquires the properties of an emulsion; while if crystals are formed at once (with low colloid content) a granular precipitate settles out immediately. As the proportion of carbonate is increased, the swelling (up to a certain point) is more apparent. Then the mass curdles and settles, but this is apparently related to side reactions in which the evolution of carbon dioxide is involved and may not be of significance. Whether or not the presence of the colloid is of more than physical significance remains to be determined. The present idea is that the colloid in some way interferes with the speed of reaction.

A study of shells during growth and of bones taken out for examination at different ages brings to light changes which have a physical as well as chemical aspect. The earliest time when calcification may be observed in certain molluscs is the appearance of a gelatinous mass adjacent to the ameloblasts. Bead-like aggregates are first formed, but these later become filamentous. As growth proceeds, the apparent viscosity of the mass increases and manipulation with microneedles is more difficult. Tearing this mass when first formed leads to quick destruction as though the aggregate were a watery solution with a coat of jelly. Later the beads are found to be more like a jelly in the process of setting. This suggests that normal growth proceeds by a series of physical changes, chief of which is the appearance of a gelatinous stage and finally a condensing and setting stage. Now, in bones, particularly in those stages where decalcification is required before sectioning, there is evidence of crystallization, while previous to this

there is absence of crystal patterns. Rats up to the eighteenth day of uterine life have bone anlages with no signs of hardening and these tissues may be sectioned without decalcification. In the 18 to 20 day embryonic material, there is at present no evidence at hand indicating any appreciable crystalline content. Beyond the nineteenth day (i.e., an embryonic age when it is required to decalcify rat limbs for suitable sections), the microsections show more definite anlage with delineation of the developing calcifying bones. Undecalcified, unfixed material from 20 day embryo-rats examined in various thicknesses indicates the presence of crystal patterns.

This is a brief statement of factors underlying the stability of calcified structures, but we have considered calcification, ossification, and changes in bones from the standpoint of growth. Instead of analyzing the bones by chemical methods, we have taken the materials which have been found in ossifying and calcifying masses and put them together. In addition, consideration has been given the chemical and physical changes which occur at various stages in precipitates of calcium salts in the hope that we may ascertain the factors related to the structural characteristics of bone and bone-like masses. We may speak of this as a synthetic approach. It certainly can be improved with the isolation of osteoblasts and a study of the growth and development of such cells in artificial media together with systematic observation by the microscope. But we can at present make observations and measurements of physical factors—both nonvital and vital—on the one hand in chemical solutions simulating the body fluids in certain particular respects and on the other hand in developing living tissues. This is one attack of importance and it is being pressed on to determine the factors underlying the stability of bones and teeth. It is but the application of well-known technical methods to a biologic problem, that is, observing tissues grow and comparing the more significant changes in the living system with those which may be observed and more carefully determined outside the body. Whether or not the stability of bones and teeth rests alone upon the formation of an oxyapatite or basic calcium phosphate is for the future to answer. Just now it appears that the stable structures of calcium compounds like bones, teeth and shells depend upon some particular association of the primary bone salts in the organic matrix involving a crystallization process and subsequent condensation or setting. Physical observations together with chemical and histologic procedures are but means to provide us with a better picture of how stable bones arise.

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[6]Hammett, F. S.: Jour. Biol. Chem., 1925, lxiv, 685.
[7]Wells, H. G.: Harvey Lectures, 1910-11, 6, p. 136.
[8]Wildt: Landwirtsch. Vorsuchsstst., 1872, xv, 404.
[9]Hastings and Sendroy: Jour. Biol. Chem., 1927, lxxi, 797.

DISCUSSION

*Dr. E. Neustadt, New York City* in presenting certain observations from his own studies of histologic sections asked why the older lamellae of bone were less reactive and stained to a lesser degree than the lamellae near the haversian canals.

*Dr. S. E. Pond.*—While a definite answer in the absence of certain essential facts is unsatisfactory, it may be presumed that the condensation processes which have proceeded longer in the older lamellae prevent diffusion of the stain. It is also possible that less reactive compounds have been formed in the solid, such as the oxyapatite in mixtures of calcium carbonate and phosphate. The oxyapatite is much less reactive than is tricalcium phosphate or the carbonates and bicarbonates of calcium.

*Dr. M. Eisenberg, Boston,* referred to his observations of the hyaline condition in certain dental sections and pointed out that the refractive index of material in bone and tooth sections strongly indicated the presence of apatite.

*Dr. A. Lees, New York City,* asked whether the oxyapatite which can be found in alkaline masses could be induced in bones and teeth by ingestion of alkalies.

*Dr. S. E. Pond.*—It must be borne in mind that the blood and body fluids are not made less acid by ingestion of alkalies at least to any great extent. We do not know the mechanism by which the intercellular fluids bathing the osteoblasts are made more alkaline. It is probable that the ingestion of alkalies would have only the remotest possibility in the desired direction.

# A CRITICAL ANALYSIS OF GNATHOSTATICS*

By A. Wolfson, D.D.S., Newark, N. J.

TO BE frank my mind is not yet made up on the validity and importance of gnathostatics in orthodontia, and this paper is an attempt to put down in writing the various conflicting views on this new subject, together with the mental process I have been going through in the last two to three years in order to arrive at an honest evaluation of the proper status that gnathostatics should have in our specialty.

When Prof. Paul Simon first came to this country to present his new methods of diagnosis based upon craniometric relations between teeth and the rest of the head, and which he called gnathostatics, there immediately arose two camps among orthodontists. On the one side and strongly supporting Dr. Simon were lined up such men as Lisher, Hawley, Waldron and Morless, and in the other camp absolutely belittling his theory were Dewey, Hellman, Stanton, and Young. The rest of the profession can be safely placed as vascillating between these two extremes. At that time, both as a result of premature judgment, as well as an unbiased piece of research work done at two museums in New York, I aligned myself with the second of the two groups.

Let us pause here for a moment to explain what this controversy is all about. As it appears to me attempts to improve orthodontic classifications hinge almost entirely about the real significance of so-called Class II Angle's malocclusions. In this country and as labeled by Angle, we have for more than twenty years recognized a type of malocclusion in which the mandibular arch was apparently posterior in its relation to the maxillary arch, as always possessing essentially similar characteristics. These were the posterior relation just mentioned, contracted arches, high palate and a protrusion of the maxillary incisors usually accompanied by mouth breathing and nasal obstruction. The treatment of these cases gradually changed both with a better conception of mechanical principles, bone growth and facial art. All of us are familiar with the earlier attempts of Kingsley to jump the bite; later improved by the introduction of intermaxillary anchorage by Baker. Angle readily accepted the physiologic benefits of intermaxillary force and incorporated it in his treatment of Class II cases with the result that, to put it in the vernacular, this treatment simmered down to a 50-50 movement. Later Dewey felt that this 50-50 movement as used by Angle would be apt to produce a posterior inclination of the maxillary incisors, as well as the posterior teeth and a corresponding mesial inclination of the mandibular teeth. For this reason Dewey recommends for the treatment of this type of mal-

*Read before the Annual Meeting of the Alumni Society of the Dewey School of Orthodontia, Hotel Vanderbilt, New York, August 29, 30, 31, 1927.

occlusion an expansion of both arches, a correction of the maxillary anterior protrusion, and then a movement of all the mandible teeth anteriorly, the entire distance.

This résumé of present-day methods of the treatment of Class II cases will suffice to show the material which Dr. Simon used as a starting point for his attempted improvement in classification. Dr. Simon's inspiration came to him from van Loon, who in 1915 presented a new method of recording dental anomalies. Van Loon felt that it would be necessary in order to thoroughly appreciate the significance of malocclusion to record the relations of the teeth to the rest of the cranium; and for that purpose he constructed facial masks with dental inserts, and oriented the entire mask from three

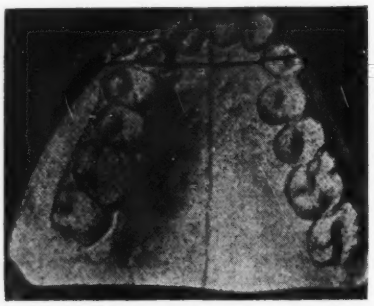

Fig. 1.

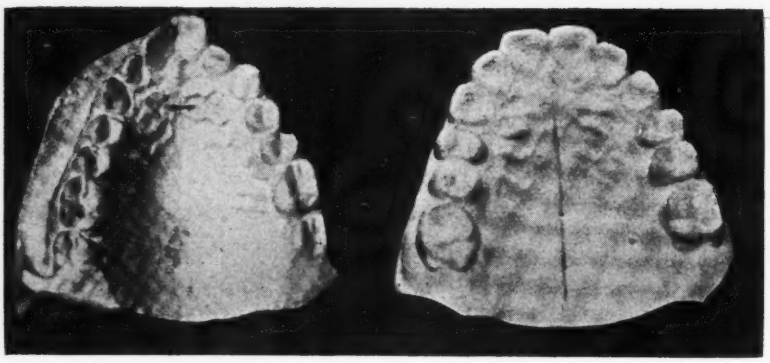

Fig. 2.

planes. At that time his work seemed very promising, but unfortunately his technic was too laborious to lend itself either to perfect accuracy or everyday practice.

Based upon van Loon's suggestion of a possible relationship between the teeth and cranium, there arose in Simon's mind doubts as to the validity of Angle's law of the constancy of the position of the maxillary first molar. In Simon's book on *Fundamental Principles of a Systematic Diagnosis of Dental Anomalies* he devotes many pages to a critical analysis of the many schemes devised in the past for the classification of malocclusion.

We are here only concerned essentially with his attack upon Angle's classification. Simon questions Angle's right to assume that the maxillary first molar is always necessarily in a fixed and an anatomically correct posi-

tion in the head. Assuming that this position may not be fixed, Simon recognized several possible ways of interpreting that type of deformity, which we have always habitually called Class II. He points out that in such deformities the following possibilities may exist.

1. Maxillary arch normal and the mandibular distal.
2. Maxillary mesial and the mandibular normal.
3. Maxillary partly mesial and mandibular partly distal.

He then proceeds to ask how one can be certain from merely looking at a set of orthodontic casts into which of the above groups the particular case under consideration will fall. These considerations compelled Simon to seek

Fig. 3.

Fig. 4.

Fig. 5.

a means of diagnosis which would not necessarily depend upon the unproved assumption of the constancy of the maxillary first molar, and he finally arrived at the need of orienting dentures in relation to three planes. At this point Simon goes into a detailed account in his book of the choice of such three geometric planes and finally presents his own scheme in which he relates the teeth to the following three planes.

1. Ear eye plane (Frankfort horizontal)
2. Orbital plane (introduced by Simon)
3. Sagittal plane or median raphe plane (Simon)

With this as a basis Simon claims to have measured a large number of skulls as well as living subjects from which he arrived at the constant rela-

tion which appears to exist between the maxillary canine tooth and his orbital plane. At this point he very cautiously and with many apologies says, "Let us assume that from my investigations, etc., the orbital plane passes through the superior maxillary canines." In addition to this revolutionary contribution he goes further and constructs graphs of the palate as well as occlusal graphs, all of which he utilizes as a finer means of differentiating dental anomalies. And for the guidance of the practicing orthodontists he presents an average curve of the palate as well as of the occlusal line based upon an average taken from four normal cases.

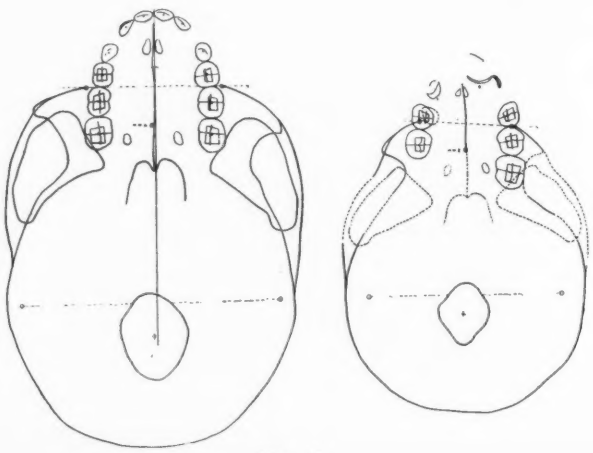

Fig. 6.

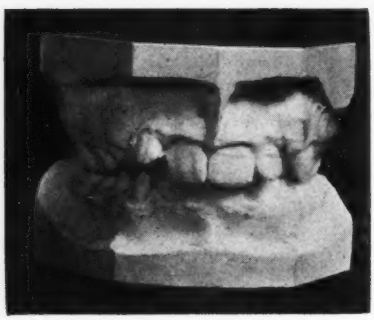

Fig. 7.

Fig. 8.

This briefly presents an unbiased account of Simon's contribution to modern orthodontics. I now want to present a criticism leveled at Simon's methods from a recent paper of Stanton. I particularly chose Dr. Stanton because of his reputed methods of exactness as being the most valid possible criticism from the physical aspect alone. With the exception of one or two, I am indebted to Dr. Stanton for all the illustrations in this paper.

Fig. 1 shows Simon's method of marking orbital plane upon the palate of the maxillary cast by means of a pointed beam scratching a 5 mm. line in the model compound impression which later becomes automatically transferred to the cast.

Fig. 2. The median sagittal plane determined by two points selected by eye on the median raphe. This is done by rotating the cast in the symetro-

graph and inscribing the continuation of the previous 5 mm. line across the entire cast. This orbital plane Simon constructs at right angles to the sagittal plane. If, however, the line as determined by the 5 mm. mark does not happen to be at right angles to the sagittal plane, Simon then makes a compromise by utilizing the left orbital point only and makes a correction accordingly. This Stanton points out as being obviously faulty engineering technic.

Figs. 3, 4, and 5 show two monkey skulls from Howe's collection for research on rickets. The larger skull is that of a normal monkey, the smaller that of one fed on a rachitic diet.

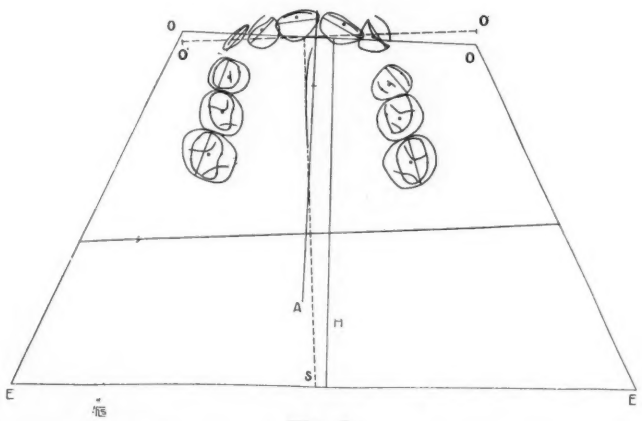


Fig. 9.

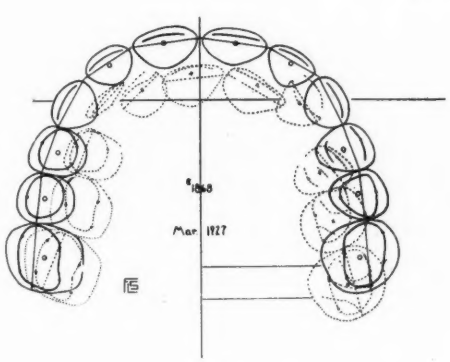


Fig. 10.

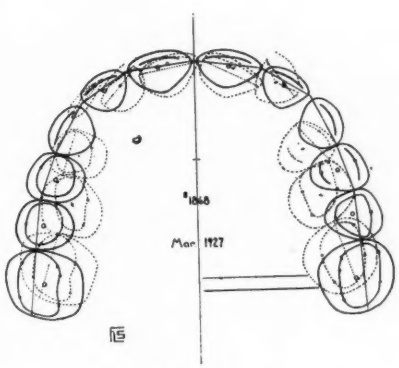


Fig. 11.

Fig. 6 shows an orthographic projection of the two skulls projected to the Frankfort plane. The larger skull shows clearly that the median raphe does not follow a straight line. Note also that in the larger skull the line joining the ear points passes near the border of the foramen magnum, and that the orbital plane passes between the temporary molars. In the smaller, a deformed skull, the ear line maintains the relation to the foramen magnum, but the orbital plane clearly shows that the deformity affected the symmetrical development of the orbital region.

Figs. 7 and 8 show an ordinary case of malocclusion.

Fig. 9 shows a plan of the maxillary teeth of this case together with Simon's sagittal plane S and Stanton's axis of symmetry A and a line H

bisecting the distance between the orbital points and tragal points. Line 0′0′ would be the orbital plane as selected by Simon, line 00, the line joining orbital points. This is shown to illustrate the discrepancy between the axis of symmetry and Simon's sagittal plane, as well as the amount of error existing in the orbital plane as selected by Simon originally, and then later corrected in order to make it at right angles to the sagittal plane. Stanton then constructed a normal arch for this case of malocclusion and in Fig. 10 shows the relation between the map of the maxillary teeth of the case of malocclusion and those of normal occlusion with the orbital planes superimposed.

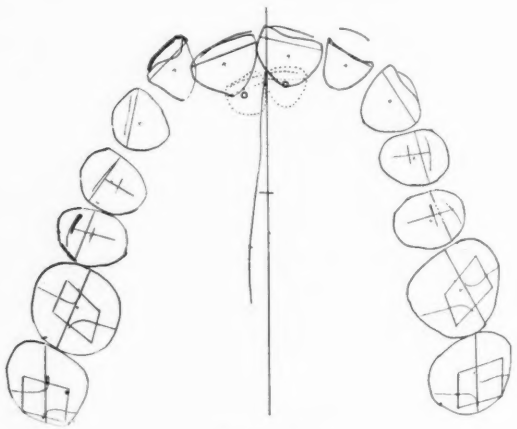

Fig. 12-*A*.

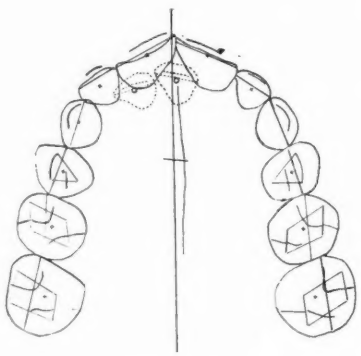

Fig. 12-*B*.

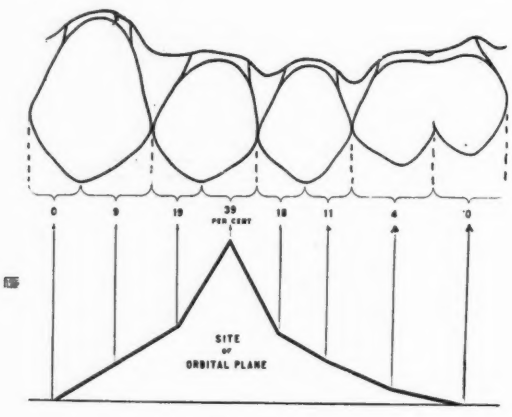


Fig. 13.

Fig. 11 shows a map of maxillary teeth in malocclusion and in normal occlusion related as regularly performed by Stanton. The foregoing two figures graphically illustrate the difference between the amount of tooth movement that would be necessary if the case were treated by Simon's method or by Stanton's method. According to Stanton for this case the total amount of tooth movement treated according to Simon is 145.9 mm., and treated according to Stanton under theory of least squares the movement would be 70.9 mm.

Figs. 12-*A* and *B* are further illustrations of the fact that the median raphe would be a poor choice for a sagittal plane.

Fig. 13, from Broadbent, illustrates his findings of a measurement of a series of skulls of American Indians. According to the graph the highest one grouping is that of 39 per cent of cases (all normal occlusions) in which the orbital plane passes through the posterior half of the first superior premolar.

Fig. 14 from Simon's book, page 367 (after Herzog), shows the figures of a similar group of living subjects in which almost 50 per cent of cases of the orbital plane passes through the middle of the maxillary canine.

Fig. 15, from Simon, shows a palatal curve in the sagittal plane. (1) Average normal; (2) from the case of malocclusion; (3) the finished case.

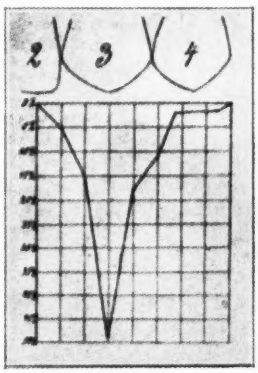


Fig. 14.

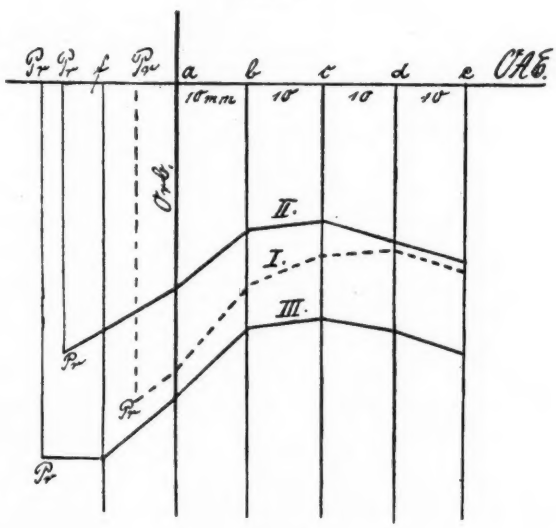


Fig. 15.

Fig. 16, from Huxley, shows the wide variation in normal palatal curves. This will serve to illustrate the futility of attempting to construct the average palatal curve.

Fig. 17-*A* shows a skull of subnormal development with Frankfort and orbital planes inscribed.

Fig. 17-*B* shows a skull in which the cranium developed normally but the face was retarded in growth. Both of these serve to show the danger of diagnosing position of the teeth in relation to the orbital plane, at least in these two cases.

Let us now point out the chief controversial points which arose as a result of a consideration of the substitution of Simon's gnathostatic diagnosis for Angle's classification.

1. The three plane system. Both Simon and Stanton are in thorough accord on the desirability of relating the dentures to three geometric planes. Both men agree on the validity of the ear eye plane, but Stanton clearly points out the pitfalls in arbitrarily selecting the median raphe plane for the sagittal plane as well as the inaccuracies of arbitrarily juggling the orbital plane.

2. The Pont Index in conjunction with his gnathostatic cases and graphs. Simon determines the necessary amount of expansion or extraction in the premolar and molar regions by measurements based upon the Pont Index.

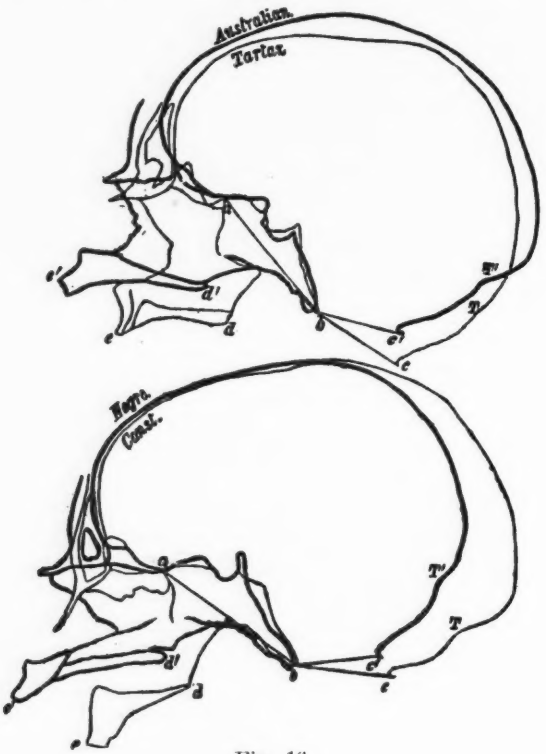


Fig. 16.

This has been clearly shown to be erroneous anthropologically, and therefore quite misleading practically. From an examination of eight pairs of casts of cases of malocclusion treated by Simon in his office, I have not been able to verify the predicted premaxillary and maxillary widths according to the Pont table nor has Simon been able to obtain these widths in his finished results.

3. Occlusal graphs. These would appear to be a valuable aid in diagnosis, but as yet Simon has not been able to show authentic average curves and very frankly admits this, and cautions his readers not to depend upon the curves shown in his book, because of the scant data from which these were constructed.

4. Occipital anchorage or extraction. If we are to accept Simon's figures we would be faced with occasionally making a choice of either using

occipital anchorage or resorting to extraction, where occipital anchorage is not feasible. I mention these two possible modes of treatment because the former has proved practically illogical and the latter is still a storm center of controversy.

In conclusion, before passing judgment upon gnathostatics we must answer for ourselves this question. Has gnathostatics any value in orthodontic diagnosis, in spite of the errors which I have pointed out in its technic, or better, will it have value if these errors can be corrected?

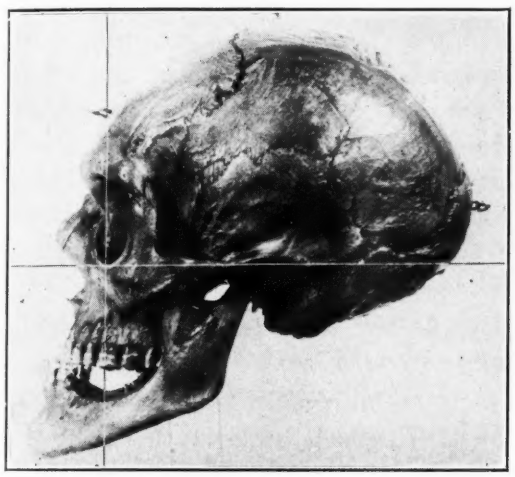

Fig. 17-*A*.

Fig. 17-*B*.

To summarize my personal opinions I would recommend the following:

1. Let us discard the orbital plane, at least until our research figures agree better than do those shown in Figs. 13 and 14.

2. Make curves, both palatal and occlusal as a means of keeping records.

3. Arrive at an adequate three plane system.

4. Make diagnoses both according to Simon and Angle on the same cases, and then compare results of treatment.

5. Get together for a deeper study of the real significance of the so-called Class II cases.

# ORTHODONTIA OF DECIDUOUS TEETH*

By Albert C. Holzman, D.M.D., Boston, Mass.

A GREAT deal of emphasis has recently been placed upon the importance of early attention to the temporary teeth. At the last American Dental Association meeting, resolutions were adopted endorsing the policy of such care. Little, however, has been done to stress the importance of correcting malocclusions in the deciduous teeth. That is the purpose of this paper. All too common is the attitude of the general practitioner to overlook or, worse still, to pass slightly by any existing malocclusion in the temporary teeth. "He will outgrow it," or "Wait until the permanent teeth come," are the phrases usually repeated by the parent when asked why treatment was not sought earlier.

The general practitioner must be taught the importance and value of early diagnosis of malocclusions and immediate treatment.

To the late Dr. Bogue is due the credit for first calling the attention of the dental profession to the importance of diagnosis and treatment of defects in the occlusion of the deciduous teeth. Having examined some thousands of children in the schools of New York, and recorded their measurements, he concluded that the arch of a child six years old, that measured less than 28 mm. across, needed expansion. This measurement is taken at the gum line between the lingual grooves of the second temporary molars. The space between the upper canines taken from cingulum to cingulum at the gum margin should be about 23 mm. These were the averages of his measurements, and others have since found them to be dependable.

It was Dr. Bogue's experience that any arch that did not come up to these measurements indicated that the child was having some impairment of function which caused an arrest of development. This impairment may be of local or constitutional origin. The diagnosis of this perverted function and its correction is important as no real success can be attained in the correction of irregularities unless normal function is reestablished.

Some of the more common causes of irregularities in the temporary teeth are enlarged tonsils, hypertrophied adenoids, thumb and finger sucking, and faulty habits of tongue, lip or cheek. Enlarged tonsils and adenoids prevent the normal action of breathing, with the result that the child's vitality is lowered and general development of the body is retarded. Any deficiency in vigor or growth is reflected in the positions of the teeth.

More than 60 per cent of all children exhibit malpositions of the temporary teeth. These malpositions are harmful to the growing child and indicate the evils to come in the permanent teeth.

*Read before the Annual Meeting of the Alumni Society of the Dewey School of Orthodontia, New York, August 29, 30, 31, 1927.

The normal for the deciduous dentition varies at different periods of development of the child. Thus at three years of age, the teeth stand close together and form a perfect arch. At five years, the teeth do not stand close together, but a spreading or separation between the incisors takes place. This spreading indicates a lateral growth of the bone to accommodate the wider teeth of the permanent dentition. Nature does not intend that the permanent anterior teeth shall erupt in too small a space or irregularly.

Therefore, a child of about six years, with its incisors standing close together, regardless of the measurements of the arch width, requires expansion in the anterior portion of the arch. A slight stimulation will produce the necessary expansion.

The dental arches of a child are given form by the action of the forces of occlusion. When this action is normal, the arch is nearly perfect. The normal action of the tongue and cheeks is in a great measure responsible for the shape of the arch. When the mouth is closed, the tongue lies in the floor of the mouth, and the force of the atmospheric pressure sucks the dorsum of the tongue against the hard palate. This flattens the roof of the mouth. As the teeth erupt, the pressure of the sides of the tongue pushes them outward until the force is equalled by the inward pressure of the lips and cheeks. If these forces are normal the teeth will form perfect arches.

When these forces are abnormal, the arches are either pressed into abnormal form, or they are prevented from developing as they should. In such cases the teeth are irregular, not from their own activity but as the result of forces acting on them.

The deciduous teeth establish the line along which the permanent teeth will erupt. It follows then that the permanent teeth will be malposed if the deciduous teeth are. The crowns of the premolars are formed between the widespreading roots of the deciduous molars, and where the deciduous molars are the premolars will come.

It has been demonstrated that there is a proportional relationship between the width of a temporary tooth and that of the permanent tooth of the same set; thereby there is an established relationship between the arch described by the temporary teeth and that of the permanent teeth. This you will recognize as demanding a system of arch predetermination, which will require too much time to go into now.

When there is sufficient room in the temporary arch for the permanent teeth that are to follow them, the four permanent incisors, when they erupt, will normally form an arch from cuspid to cuspid, just outside the line formerly occupied by the cutting edges of the temporary incisors.

The permanent cuspids should erupt about where the temporary cuspids stood, only a little outside the line of the temporary arch and the premolars should erupt exactly beneath the temporary molars.

The various types of malocclusion found in the permanent teeth may be found in the deciduous teeth. The methods of treating them are similar, only finer gauge wires can be used. A *very* slight pressure will move temporary teeth. Generally, if the patient is less than six years of age, not more than $\frac{3}{16}$ of an inch will be required to spread the arches enough to permit the

orderly eruption of the permanent teeth. The measurements and calculations of the size of the arch will determine how much expansion is needed.

Frequently, the application of mechanical stimulus in one arch will bring about an expansion in the opposite arch due to the occlusion. It has also been observed that after more space has been created, permanent teeth that are out of line or rotated slightly will move into proper positions without any mechanical aid.

As a large number of malocclusions in the permanent teeth are caused by early loss of deciduous teeth, it is necessary that some means be used to prevent the drifting of the teeth on either side of the tooth that is prematurely lost. This is best done by space retainers. A nonrigid appliance is preferred, thus permitting individual tooth movement and function. When a deciduous molar is lost, an appliance with two wires, one soldered to the labial surface of the band on one tooth, and the other to the lingual surface, and both resting in corresponding labial and lingual loops or rings on the band of the other tooth, will be found to be very effective. This type of space retainer permits the premolar to erupt without interference.

In conclusion, when one can diagnose an arrest or lack of development in the temporary arches, treatment should be instituted to stimulate growth of the maxilla or mandible to obtain space to accommodate the larger permanent teeth. Having acquired the necessary space, the case should be under periodic observation until the permanent teeth are in place. The time required to spread the arches is relatively short.

It seems, therefore, that it is good practice to correct malocclusions of the deciduous teeth at any age when it may be done easily and painlessly when by so doing you enhance the possibility of the permanent teeth erupting in normal positions.

# A REVIEW OF THE LITERATURE PERTAINING TO THE INFLUENCE OF HABITS IN ORTHODONTIA*

By M. B. Markus, D.D.S., Philadelphia
*Instructor in Orthodontics, Dental School of Temple University*

IN REVIEWING the literature pertaining to the influence of habits as a contributory factor in producing malocclusion of the teeth, we find that the field is rather limited and deals mostly with the effect of the various pernicious habits on the dental apparatus. The articles written by Dearborn, LeRoy Johnson, and Pullen are considerably more broad in their scope and also deal with the biologic and psychologic phase, the evolution, modus operandi, and results of good and bad habits. Very little is said about the specific way in which these particularly bad habits are formed and the therapeusis conducive to the prevention or correction of these habits.

As to the nature of habits, all the writers seem to agree that it is a fairly constant or fixed practice established by frequent repetition, that its purpose is to save time and energy, i.e., in the words of James, "simplify our movements, make them accurate, and diminish fatigue"; that in living matter it is largely dependent upon the plasticity of the individual, that in fact all life processes which are not voluntary belong to the realm of habits. Acts which at first are voluntary are conscious. After certain repetition they become automatic or habitual and thus escape the censorship of the mind. Thus most of the habits are in the final analysis neuromuscular reactions. Some of them are initiated at a high physiologic level, such as walking, when a child learns to walk and where the cerebrum is directly concerned. As time goes on, walking becomes automatic and is removed from the realm of the conscious mind to that of the subconscious; however, it may be that habits relieve our conscious minds of a great number of troublesome details, and thus again diminish fatiguability.

Habits are dependent upon several factors in their formation. In the first place, a great many of them are the result of the instinctive life of the individual. This instinctive life does not appear to be very clearly defined in the minds of the writers on psychology, but they appear to be tendencies inherited by the race as a whole, so that responses to common stimulation are fairly uniform; such, for instance, is the sucking habit, which is common to all mammals.

A great many of the other habits result from the repetition of a pleasurable act, or the repetition of an act, the purpose of which is to avoid pain. These habits are spoken of as due to a result of action. Again, some habits are dependent upon the nature and degree of stimulation; in other words, in a broad sense, upon some defect in the former, or the latter, or in both.

*Read before the Annual Meeting of the Alumni Society of the Dewey School of Orthodontia, New York, August 29, 30, 31, 1927.

The neurologists recognize two important factors in the production of harmful habits. The first is the neurotic or neuropathic heritage, for in an individual that is born with a subnormal nervous resistance and abnormal sensitiveness to ordinary stimuli, there is a tendency to deflection from the normal upon the slightest provocation, and a tendency to the formation of early neuromuscular maladjustments, which manifest themselves in abnormal habits. The children with this heritage often have neurotic parents and are doubly harmed by their inherent biologic make-up and by the chances for mimicking their parents with obvious harmful results.

The second factor, in the words of Adolph Meyer, is the situation factor which has to do with the child environment and is intimately concerned with his every-minute life, and with his attitude to all animate and inanimate objects with which he comes in contact.

As to the nature of the specific pernicious habits of interest in malocclusion, we find the literature fairly abundant. The outstanding feature concerned in the etiology is that most of these habits arise from the instinctive life of the infants.

It follows as a corollary that the prevention, as well as the cure of these habits belongs in a large measure to the pediatrician and neurologist. The pediatrician sees the sucking habit in its inception, and is the one most likely to influence its continuance. The child who grows up with a sucking habit in all probability has a great many other maladjustments, for it is well recognized that bad habits are only an indication of a general instability or lack of equilibrium of the nervous organization. If this be the case, it belongs to the realm of neuropsychiatry, where a careful analysis of the situation and the make-up of the individual will lead to appropriate corrective measures.

I would like to briefly review the individual habits and their possible relation to malocclusion. Pullen states that many of the simple cases of malocclusion, as well as those of a complex character, are directly or indirectly traceable to abnormal habits of a neuromuscular nature. Inasmuch as these habits are intimately concerned with the muscles of the face and oral cavity, the lips, cheeks and tongue, the abnormal forces which are called into continuous or frequent intermittent action have the effect of not only changing the normal form of the dental arch to the abnormal one, normal positions of individual teeth to malpositions, but of causing malocclusion and facial deformities which are characteristic of the particular neuromuscular habit involved.

### THE SUCKING HABIT

Its etiology is relegated to the domain of instinctive life, that it is a habit common to all mammals which to a certain extent is normal and only becomes abnormal when used to excess and continuing from infancy to childhood. It is often initiated by the use of pacifiers by the mother, nurse, or even physicians. It is assumed that the act is pleasurable to the child, and eventually becomes as indispensable as smoking is to some of us. Its effect upon malocclusion has been described by most writers, but I will briefly enumerate the following points:

The act of placing the thumb, the fingers or any other object into the mouth at various times, and contracting the lips, cheek and tongue upon same, thereby causing a partial vacuum to be formed within the oral cavity, is bound to influence the development of the jaw bones, particularly of the upper jaw. In cases where this habit is being indulged in to a mild degree, there is usually a protrusion of the upper centrals or both the centrals and lateral incisors. In the more active cases of this type, there may be a contraction of the lateral halves of the arch, that is, the normal lateral development will be interfered with. There may also be associated with the protrusion of the upper anterior teeth, a depression of the lower anterior teeth.

Some of the older authors have contended that the pressure of the thumb on the hard palate in these cases of thumb-sucking was responsible for the high type of vault. I do not believe this thought is given much credence today.

As to its therapeusis, prevention is the keynote, and here again I cannot help but reiterate that the pediatrician should become most interested. As to the correction of the habit already formed, by means of various mechanical appliances, such as mitts, splints over the elbow, application of distasteful substances, etc., are well known and useful only in the very young children. In the older child, sucking habits are only one of many manifestations of nervous instability and should be referred to the neurologist for treatment.

### MOUTH-BREATHING

Very much has been written about it and its harmful effects. If there is a nasal obstruction, the child is obliged to breathe partly through the mouth. Furthermore, if the dental arches are not in proper apposition, it is impossible for the mouth to be kept closed; therefore, mouth-breathing is really a necessary action and cannot be considered a purely pernicious habit. I believe mouth-breathing is being considered today, not so much the cause of a malocclusion, but the result of a malocclusion. After all nasal obstructions are removed and the teeth placed in proper occlusion, I believe the habit will disappear, with the assistance of the will of the patient. The practice of utilizing muscular exercise is somewhat helpful in restoring the condition to normal by stimulating some of the muscles which were not functioning very much while breathing through the mouth was taking place.

### THE BITING HABIT

It is interesting to note that the biting habit, which is considered not an infrequent cause of malocclusion, is not even mentioned in most books on pediatrics. It is generally conceded in our literature that its etiology is very similar to that of the sucking habits, and its treatment is principally psychotherapeutic and as such should be referred to the neurologist.

Biting of objects, such as pencils or the lip, particularly the lower lip, or the tongue, etc., will cause a protrusion of the superior incisors. This protrusion may be slight or may become more marked, depending upon the size of the object, and to the extent of which the habit is indulged. In these

cases there may also be a depression of the inferior anterior teeth. If this habit is somewhat extensive during the time the anterior permanent teeth are being erupted, an openbite may result.

### POSTURE HABITS

This class of habits, particularly the pillow habits, have been fully considered by Dr. Harvey Stallard in the *Dental Cosmos.* In reviewing the literature, I believe he was the first man to have written and investigated this class of habits and their bearing on malocclusion. He has gone into the subject very thoroughly. Pillow habits, Stallard contends, have their origin from the improper manner in which the mother allows the infant or child to sleep. With the Indians and other less civilized races of human beings, the act of swaddling was very common, that is, the infant was bound up rather tightly in blankets or cloths and carried about in this manner. This prevented the infant from laying its head upon the extremities or any other object, thus preventing the exertion of any pressure upon the skull. The fact is pointed out that, in the modern infant which is allowed to lie upon its back, there is a flattening of the occiput, which is missing in the other tribes just mentioned. This, Stallard claims, is proof that the weight of the head resting upon an object will exert sufficient pressure to alter the shape of the bones of the skull. There is also a prevalent practice on the part of the mother in these modern times to place the infant upon its stomach, if it is restless, as this will tend to soothe the infant. Thus pressure will be exerted upon the anterior regions of the maxillae, probably giving rise to some form of malocclusion. So in this wise many improper habits of sleeping are developed at a very early age, and will continue throughout life. Some of these habits are originated later on in life, due to some peculiar posture the person is obliged to assume in its coping with many conditions arising throughout life.

If these habits continue over a period of time, they may affect the development of the jaw bones as well as other bones of the skull, giving rise to cross-bites and Gothic arches. Cross-bites are formed by a lingual occlusion of the upper bicuspids and molars to the lower side teeth on one side only. If this condition is bilateral, it is known as a Gothic arch. In these latter cases there may also be a lingual deflection of the crowns and a lateral inclination of the roots of the lower side teeth, thus accentuating the condition. Some of the types of malocclusions resulting from these pillow habits, as Stallard claims, are somewhat typical of cases which some authors attribute to malnutritional disturbances as rickets, or to some endocrine disturbance. Stallard, however, suggests that these conditions, if present, make the field more fertile, that it will be easier for the habits to leave their influence upon the jaws.

There are various forms of these habits. A person may rest the head directly over the arms or hand, or may have the pillow intervening between the face and the arm. In this latter case, the resulting malocclusion is supposed to be less marked than in the former. Burying the head into pillows may also have its harmful effects.

Stallard states that this habit is very prevalent, that 15 to 20 per cent of Californians are affected with Gothic arches and cross-bites. He claims that these cases are usually the result of bad sleeping habits. To my mind, this seems just a trifle dogmatic. We all are aware of the very complex nature of malocclusion and of its very complex etiology. To single out just one mere habit as being directly and solely responsible for a fairly common form of malocclusion, seems to me as just being a trifle too enthusiastic.

All of the above habits mentioned may be present singly or may be acting in combination with each other. The thought should be remembered that if any of the above habits are present in a case of malocclusion, there may also be other factors present which will have a bearing upon the etiology of the case. There are many other individual neuromuscular actions about the mouth which will at least in part be responsible for some form of malocclusion.

In conclusion, I would like to reiterate the following points:

1. Through the efforts of Johnson, Dearborn, and Pullen, the nature of normal and abnormal habits and their relation to malocclusion have been fairly well elucidated.

2. The specific etiologic factors concerned in special bad habits are factors belonging to heredity, and include the so-called neuropathic or neurotic predisposition and detrimental environmental situations.

3. That the evaluation of these factors is indispensable for the prevention and cure of these habits, and belongs to the realm of pediatrics and neuropsychiatry, lastly.

4. The plea is here made for closer cooperation between pediatricians, neurologists and orthodontists.

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Empire Bldg.

# THE GROWTH OF THE ALVEOLAR BONE AND ITS RELATION TO THE MOVEMENTS OF THE TEETH, INCLUDING ERUPTION*

By James C. Brash, M.C., M.A., M.D., Birmingham, England
*Professor of Anatomy, University of Birmingham*

*(Continued from April issue.)*

## MOVEMENTS OF THE TEETH IN THE PROXIMAL DIRECTION IN THE GROWING ALVEOLAR BORDER

THE third line in which teeth may move in the alveolar border is the proximodistal, and we may again note the necessity of postulating a movement forward of the molar teeth in the human jaws if the deciduous and permanent arches are to be superimposed by means of the incisors, a necessity that becomes the more imperative in view of the labial movements of the incisors as the arch grows. But we do not yet know the exact mode in which the anterior part of the human arches is reformed during growth, and the relation there between oblique direction and labial movements of the teeth. In the pig's jaws on the other hand, if the attempt be made to superimpose the deciduous and permanent arches by means of the incisors (taking no account of the obviously great forward growth in that region), then it is clear that there must be a backward movement of the cheek teeth—a result which is so obviously wrong that we fall back upon the growth point of view for a solution.

Now during the growth of the pig's jaws there is a constantly increasing interval between the central incisors and the second deciduous molar or premolar teeth, with constantly increasing spacing between the canine and the teeth on either side of it. This separation is a feature of the growth of the jaws in many animals, extending in some to the other premolars, and it is still sometimes attributed to "interstitial growth." This hypothesis is no doubt the only possible explanation of the erroneous assumption that the plane of the alveolar border is stationary, and that the growth of the jaws takes place at the nonalveolar border. It is, however, clear in madder-fed animals that the increasing separation of these teeth and the widening of the part of the arch in which they are set is associated with the growth of the border in an oblique direction and the labial movements of the teeth. The same factors must account, as I have already suggested, for the widening of the arch and the separation of the deciduous teeth in the human jaws.

It might be settled by measurement, if a sufficiently large series of jaws were available, whether the lengthening of the anterior part of the arch by these means does in fact account for the amount of spacing that is observed between the teeth. If not, then the cheek teeth must have moved back-

*Read before the British Society for the Study of Orthodontics.

wards, but if on the other hand the oblique growth of the alveolar border and the labial movements of the teeth combined are more than sufficient to account for the spacing of the teeth, then it would be equally certain that the cheek teeth had in the meantime moved forward in the border, and by so doing had diminished in proportion the amount of space gained by the other method. There is, however, absolutely no means of determining by measurement alone what is happening in this region, but the evidence from madder specimens points undoubtedly to the latter of these two suppositions as the correct explanation of what occurs.

There are in fact three sources of evidence in madder specimens for a proximal movement of the teeth in the alveolar border; of these, two are direct and the third indirect. (1) The first is the distribution of new bone in the walls of the alveoli. I may recall here the passage previously quoted concerning the difficulty introduced by the vertical movement of teeth with spreading roots, and the consequent effect on the distribution of new bone and absorption in the walls of the alveoli. Nevertheless, when this is taken into account and the necessity of interpreting every detail of appearance in madder specimens fixed firmly in the mind, the picture that begins to present itself in broad outline is a clear and a constant one; as detail after detail is rigidly examined and fits itself into the general scheme, forward movement of the teeth in the alveolar border becomes as certain as upward and outward. The indication of proximal movement in the case of a tooth set vertically in the border is the presence of new bone on the distal wall of the alveolus, while on the proximal wall either it is present in much smaller amount or a red appearance indicates actual absorption. In varying degree, and combined in various ways with the other types of distribution which indicate movement upwards and labially, this arrangement is to be found in the alveoli of all the teeth in the pig's jaws.

The clearest evidence for a proximal movement of the teeth, from the point of view of the distribution of new bone in the alveoli, is to be found in the case of the second and third deciduous molars, which are set nearly vertically in the jaws. An examination of the distal surfaces of the alveoli from before shows that they are covered with new white bone; turn the jaw round and the red appearance of the proximal surfaces is equally striking. So with the fourth deciduous molars and the permanent molars in succession, depending upon the age of the animal, though here the combination of upward movement with oblique roots and the rotation which takes place during the eruption of the molars has its effect, so that the distribution of the new bone varies in the lingual and buccal alveoli. I am well aware of the effect of a slight obliquity of the teeth, and have taken this into consideration in making these observations; but the fact that these teeth have obliquely separated roots renders in some specimens the evidence for forward movement only the more conclusive. It was the combination of the different movements, as I have already pointed out, as well as the fact that owing to upward movement the lower portions of the alveolar walls alone are available

for observation, that made it a little difficult at first to arrive at the true explanation. Detailed study has, however, convinced me that forward movement is a reality.

I think it probable, however, that conviction in others may also depend upon personal examination of the details in the individual alveoli; the difficulties of illustrating these details *in extenso* are considerable, and pending the elaboration of some method of doing so that may enable me to give a complete description of the whole course of the movements of each tooth individually, and at the same time to provide a comprehensive view of all the movements of all the teeth in the jaws of the pig, a modification of the previous diagram to illustrate the principle of the distribution of new bone as teeth move forwards may help to sustain and clarify the argument.

In the first diagram (Fig. 9) I have shown the distribution of new bone and of absorption areas in the alveoli of a tooth with spreading roots, applicable alike to mandibular roots in the proximodistal, and maxillary in the buccolingual directions. That diagram may be easily modified, not merely

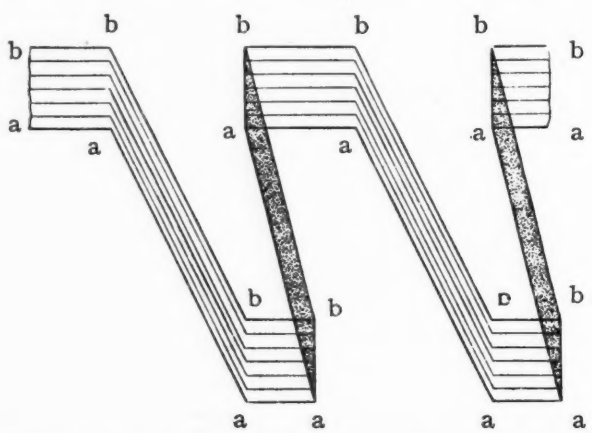


**Fig. 19.**—Diagram of the sites of bone deposit and absorption associated with the vertical rise of a tooth with double obliquely parallel roots: *a-a-a* and *b-b-b*, original and new surfaces of alveolar border and alveoli. The sites of deposit of new bone and the successive positions of the new surfaces are indicated by the series of parallel lines, and the sites of absorption by stippling. Bone deposit and absorption overlap at alveolar edge and apex as in Fig. 9. *Cf.* also Figs. 20 and 21.

hypothetically but in actual accordance with the observed facts, to show the distribution of deposit and absorption during vertical rise when the roots, as they often are in mandibular teeth, are set obliquely in the same direction instead of being separated from each other (Fig. 19). Equally well these two diagrams may be modified to illustrate the effect of a combination of forward with upward movement of the two types of teeth, obliquely set with parallel roots and vertically set with diverging roots. In the particular modifications shown it is assumed that the forward movement of the teeth has been equal to the horizontal distances in the other corresponding diagrams between the original and final positions of the alveolar surfaces of the interalveolar septum (Figs. 20 and 21).

These diagrams speak for themselves, but it may be pointed out that the new bone formation, apart from the upper portions of the alveoli which are entirely new, is now found on the distal surfaces of both alveoli and on the apices; absorption is limited to the proximal surface of the proximal alveolus

of the tooth with divergent roots, including a small portion of the new bone at the alveolar border, while the proximal surfaces of the distal alveolus in this tooth and of both alveoli in the other have suffered no change at all; a more extensive movement in the proximal direction, or the same movement with less in the vertical, would be accompanied by absorption on these surfaces also. Description of the process in such terms may sound a little complicated, but an ocular demonstration of the changes that take place may be readily obtained by the simple expedient of making an opaque copy of the original alveoli on transparent paper, by superimposing this upon the diagram in its original position and moving it in the required direction.

It need only be added that if the distribution of new bone and absorption that must accompany vertical movement of teeth with oblique or divergent roots be kept carefully in mind, then variations in the directions indicated in these diagrams prove only the more conclusively that forward movement has taken place. If we compare Fig. 19 with Fig. 20, this point is very strikingly brought home. At first sight the distribution of new bone in Fig. 19

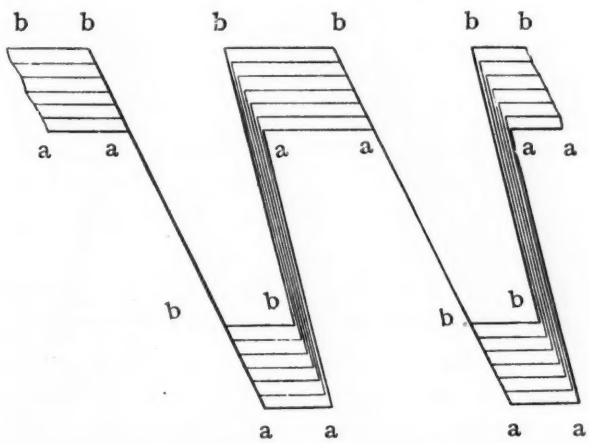


Fig. 20.—Diagram of the sites of bone deposit and absorption associated with vertical *and forward* movement of a tooth with double obliquely parallel roots: *a-a-a* and *b-b-b*, original and new surfaces of alveolar border and alveoli. The difference between this figure and Fig. 19 is explained in the text. *Cf.* also Figs. 9 and 21. This diagram represents the probable main changes associated with the rise and forward movement of the human mandibular molars.

might easily lead us to suppose that the tooth had actually moved backwards, if we did not fully realize that a vertical movement of a tooth must be accompanied by deposit of new bone on the lower surface of the alveolus whether proximal or distal. An intermediate stage between these two diagrams might easily be prepared to demonstrate that in certain circumstances a proximal movement of a tooth may even be accompanied by new bone on the proximal surface of its alveolus and absorption on the distal. It is clear also that if a tooth is obliquely set in the alveolar border with its crown in advance of its roots, as is indeed the case with many teeth, then a simple elevation of the tooth in the direction of its long axis will necessarily lead to its simultaneous advance. The important point is that all these variations and the corresponding types of distribution of new bone and absorption are not merely hypothetical, but are in fact to be found in the movements and in the alveoli of the teeth of the pig.

(2) The second source of evidence for forward movement of the teeth is

to be found in madder specimens in the actual relation of the new white inner edge of the alveolar border to the original red inner edge which is clearly visible below it. This relation is much more obvious in the mandible than in the maxilla for reasons already stated in the discussion of labial movements. It was illustrated in Fig. 9 in my first Dental Board lecture in 1924, though not very clearly, as I did not then realize its true significance.

If the inner aspect of the mandibular alveolar border be examined closely, it will be observed that from the region of the first deciduous molar backwards the relation of these white and red edges suggests that the individual alveoli have not only altered their position in the upward direction but that they have moved distinctly forward (Plate II). All the hollows and elevations of the alveoli and septa are in advance of the exactly corresponding points visible in the wavy outline of the former edge. This is not only so with the alveolar outline of the very obliquely set first deciduous molar, but is also to be observed in the minutest detail, including the positions of the "gubernacular" orifices of the premolar crypts, with all the other alveoli.

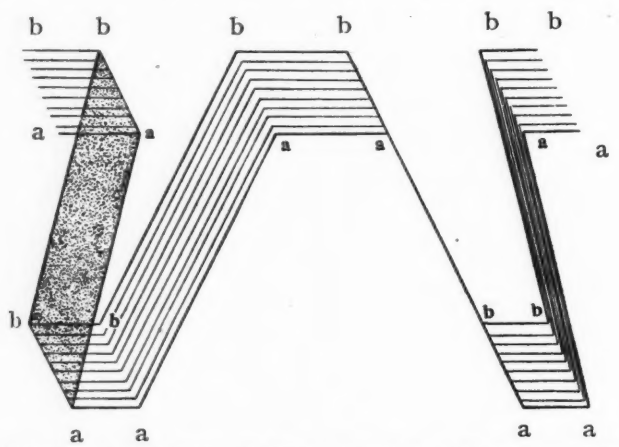


Fig. 21.—Diagram of the sites of bone deposit and absorption associated with vertical *and forward* movement of a tooth with double obliquely separated roots; *a-a-a* and *b-b-b* original and new surfaces of alvolar border and alveoli. Compare particularly with Fig. 9, to which this diagram is complementary, and also with Figs. 19 and 20. This diagram applies equally well to the changes in the lingual and buccal alveoli of a maxillary tooth moving upwards *and outwards.*

irrespective of their set in the border. Not only is the inference clear, but we possess in this relation a means of measuring directly the advance of the teeth, which is very welcome in view of the very great difficulty of relating the comparatively small increments on the walls of the alveoli to the various angles of their slope.

Without detailing the individual measurements, I may say that a calculation from all the mandibles available indicates that the cheek teeth are advancing in the alveolar border of the mandible of the pig from the tenth to the thirty-second week at a rate varying from a mere trace in the earlier stages to 0.25 mm. a week in the later. The average rate of advance during this period is 0.175 mm. per week, and although this may appear to be a small amount, yet it means an advance of the teeth of nearly 4 mm. in the period covered, and even on the assumption that this average rate is maintained—and all the appearances are in favor of a steady increase in the rate as the molars erupt—it means that during the period of the eruption of the

molars which, including the complete separation of the last molar from the root of the coronoid process, extends over some eighteen months, the cheek teeth in the pig have advanced *in the alveolar bone* to the extent of nearly 14 mm. As the crown of the first permanent molar measures from 17 to 18 mm. in the proximodistal direction, if we allow for only a very slight increase in the rate of advance, we are justified in concluding that the forward movement of the molars during the period of their eruption as a whole may amount to a displacement equal to the diameter of the first of the series. Such a movement would considerably minimize the importance of the "cutting back by absorption" of the anterior border of the coronoid process to set free the molars as they erupt, considered by most since the time of John Hunter to be a fundamental point in the growth of the mandible. I believe, with Mr. Wilson Charles, that absorption of the coronoid has been much exaggerated, not only because I have satisfied myself that the molars move forward, but also for other reasons (different also from his) which become of importance in connection with the third and indirect source of evidence for that forward movement.

(3) As I have just indicated, it has been generally believed, since John Hunter's original description of the growth of the mandible, that extension backwards of the ramus and simultaneous absorption of the anterior border of the coronoid, though to a smaller extent, are sufficient explanation of the appearance of the molars from beneath its root and of the slow increase in breadth of the ramus itself. But this conception, like the vertical growth of the body, falls now to be reviewed in the light of our new knowledge of the continuous and all-important upward growth of the alveolar border, as well as in relation to the forward movement of the teeth.

Space for the successive appearance of the molars from the root of the coronoid is, I believe, obtained in three ways: (*a*) by the upward growth of the alveolar border carrying the teeth with it in relation to the sloping anterior border of the coronoid, the amount obtained in this way varying in different animals and at different ages according to the set of the coronoid; (*b*) by the forward movement of the teeth themselves; (*c*) by absorption of the anterior border of the coronoid.

I have placed these three factors in the emergence of the molars in what I believe to be the order of their importance. Nevertheless, the question of the amount of the absorption of the coronoid and its relation to the form of that process is of fundamental importance for the study of the growth of the mandible as a whole. I hope later to show that absorption of the coronoid falls into line with generalizations founded on other evidence, in that it is limited to a molding of its contour as the coronoid and the alveolar border both grow upwards, incidentally assisting to open out the mouths of the crypts of the molars in succession as they also rise and move forward. With these remarks I may now proceed to point out the basis of the third possible source of evidence of the forward movement of the teeth.

If it becomes possible in the development of this work to estimate the amount of space, if any, provided for the molars in succession by absorption

of the anterior border of the coronoid, and by careful measurement of the angles between the vertical axis of the alveolar border in the molar region and tangents to the anterior border of the coronoid, to estimate the amount obtained by direct upward alveolar growth, then any additional space required to account for the emergence of the molars would necessarily be due to their actual forward movement. But the old difficulties of finding fixed points from which to measure and compare increasing width of ramus with observed amount of bone addition to its posterior border, and the individual variations which necessitate a very large series for any such procedure, have hitherto prevented me from coming to any satisfactory conclusion on these lines. It has, however, been borne in upon me that absorption of the anterior border of the coronoid is undoubtedly very small, and confirmatory evidence of the forward movement of the molars may perhaps be forthcoming through other methods of estimating it.

To sum up the position with regard to forward movements of the teeth in the alveolar border, there is evidence from two sources that the cheek teeth of the pig do in fact move in that direction; an estimate can be made of its amount from direct evidence, and the immediate conclusions which follow are these: First, we can be directly certain that in investigations of changes in the alveolar arches we are no longer entitled to assume that the first permanent molar is a fixed point any more than any other point in the "system of relativity" that constitutes the jaws. It moves not only upwards and outwards in the alveolar border but also, and at the same time, in the third direction as well. Secondly, a continuation of forward movement of the molars with lack of expansion of the anterior part of the arch for whatever reason—lessening obliquity of the border there, or relatively deficient growth—will lead directly to a crowding of the teeth; we have here the evidence for a movement which I think I am right in saying has long been taken for granted by many dentists as one of the causes of such crowding.

All the observations upon which the conclusions regarding the forward movement of the teeth have been directly based have been made in the mandible; there are difficulties in the way of making entirely satisfactory observations of the same nature in the maxillae. Not only is the red edge of the original alveolar border covered in part by bone additions associated with the descent of the palate, but also, as we have seen, the amount of alveolar growth is not so great. Direct observation of the interior of the alveoli, however, undoubtedly shows that the distribution of new bone and absorption is on the same general lines. The indirect method, corresponding to that suggested for the mandible, by using the backward travel of the malar process, suffers also from corresponding difficulties, and moreover is less satisfactory on its own account, because of the changing form of the malar process and the difficulty in the pig of determining its exact relation to the alveolar border. The impression I have received from a careful comparison with the mandibular alveoli is that movement of the teeth forward does in fact take place in the maxilla, but that it is less extensive than in the mandible.

A discussion of the possible reasons for this, in the absence of precise

knowledge of the relative extent of these movements in the two jaws, would lead us too far at the present time, but it may be suggested that there are other observations which fit in with the probability that movement forward in the maxilla is less than in the mandible. One of these is that forward growth of the jaws in the region of the incisors is greater in the mandible than in the premaxillae, a possible explanation of which may perhaps be found in the fact that the maxillary and mandibular borders as a whole are related to each other in a sagittal plane in much the same way as their molar regions are related in a coronal (Fig. 18). Both the borders in the region of the cheek teeth slope slightly upwards from behind forwards, and it would appear that downward growth of the maxillary border would in itself thus carry the teeth forward to some extent as the molars are carried outward, but that, on the other hand, there would be a correspondingly greater necessity for the mandibular teeth to move forwards in a border rising in an opposite direction in order to maintain their occlusion. The forward growth of both jaws in the incisor region is associated with the progressive spacing of the anterior teeth, and the extra forward growth of the mandible might thus be accounted for by the sagittal relation of the two borders and the necessity of providing for the greater forward movement of the mandibular teeth. These, however, are but tentative suggestions, the proof of which will depend upon the possibility of determining precisely the relative amounts of growth and of the movement of the teeth in relation to the reciprocal curvatures of the alveolar borders.

It remains to observe, apart from the importance of the conclusions presented regarding the forward movement of the mandibular teeth for the etiology of crowding of the arch, that it is highly probable that the necessary adjustments of the normal occlusion which take place during the transition from the deciduous to the permanent dentition in the human jaws are brought about by a mechanism depending upon the relatively greater forward movement of the mandibular teeth in the alveolar border. In this way the vertical straight line of the distal surfaces of the second deciduous molars, which marks the termination of the eruption of the deciduous dentition, may give place to the overlapping relation of the permanent molars coming in behind which determines the permanent occlusion which we call "normal."

*(To be continued.)*

# Case Reports

## REPORT OF CLASS I CASE CHARACTERIZED BY GREATLY DISPLACED AND ROTATED UPPER INCISORS DUE TO SUPERNUMERARY TEETH AT MEDIAN SUTURE.*

By Harry E. Kelsey, D.D.S., F.A.C.D., Baltimore, Md.

THIS case illustrates well the very disfiguring malocclusion which can result in an otherwise normal mouth, from the presence of supernumerary teeth in the region of the median line of the maxillary arch.

Some authors have blamed dentists in whose hands these patients have been from an early age, for not discovering and removing the supernumerary teeth in time to prevent the malocclusion, but this is a rather unjust accusation in most instances, because while it is undoubtedly a good thing to x-ray patients of all ages to discover any anomalies that may exist and which are not visible, yet when this is done it would usually be an impracticable operation to go in deeply for supernumerary teeth in the mouth of a child, that is, while the deciduous incisors were still present, as there would always be danger of injuring the permanent incisors, though, of course, the extraction should be made as early as is feasible.

In the case presented, it could have been done much earlier than it was, though some malocclusion would have existed, in spite of the fact that in all other respects, conditions indicate that the occlusion would have been normal.

The case responded well to treatment, but the teeth showed a recurrent tendency toward rotation for some time afterward, which finally disappeared during a period in which the patient wore a Hawley retaining plate with decreasing regularity. The ribbon arch and bracket bands were mainly used in the treatment. Fig. 1 shows front view of case just before beginning treatment. Fig. 2 shows right and left side views. Fig. 3, front view of case a year after treatment and retention had been discontinued. Fig. 4, right and left side views. Fig. 5, occlusal view of casts before and after treatment, the one before treatment showing peg-like supernumerary teeth one on either side of the median suture.

833 Park Avenue.

*Case report read before the Twenty-sixth Annual Meeting of the American Society of Orthodontists, Chicago, May 2-5, 1927.

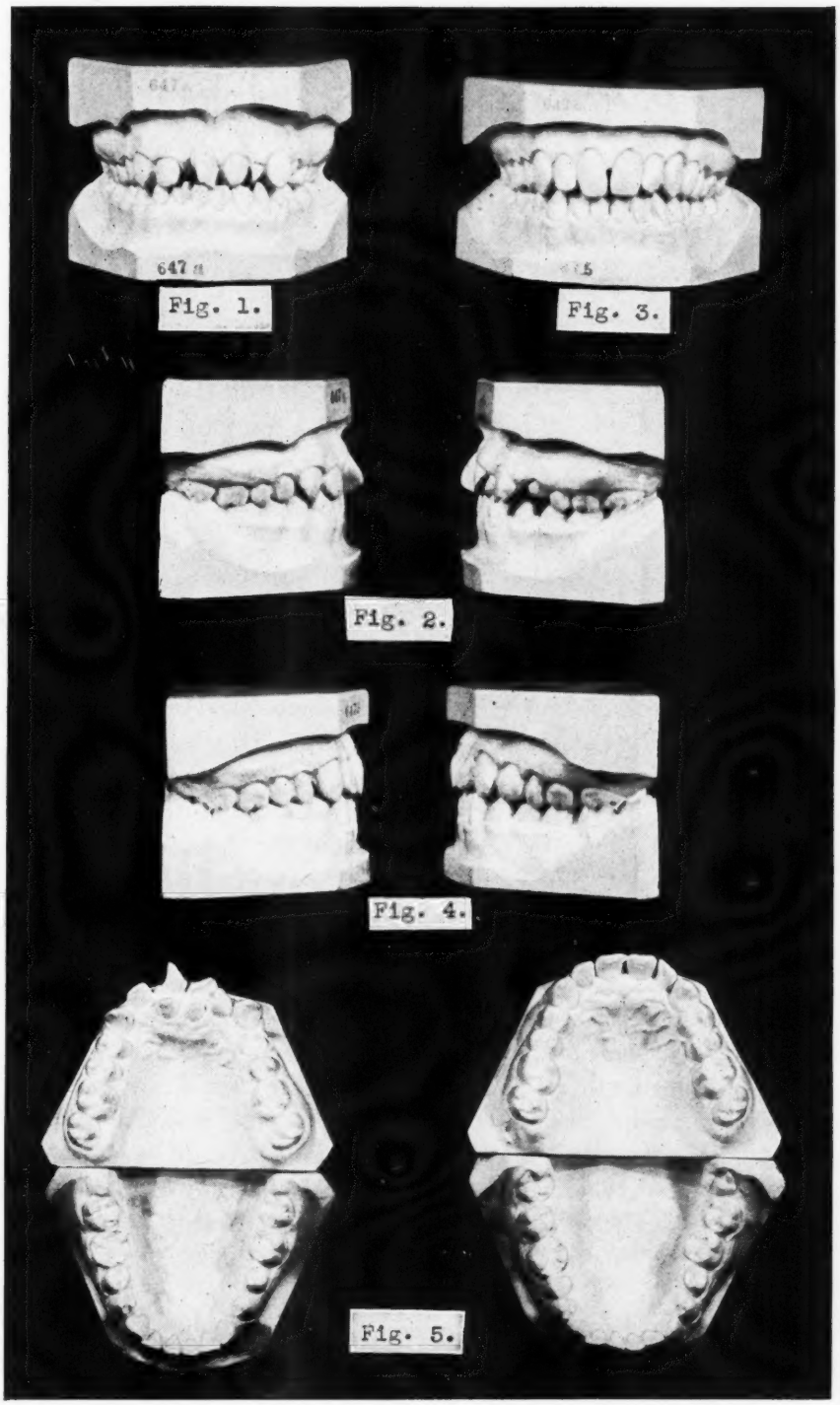
Fig. 1.
Fig. 3.
Fig. 2.
Fig. 4.
Fig. 5.

# THE TREATMENT OF A CASE REQUIRING DIVERSIFIED TOOTH MOVEMENT USING THE OPEN TUBE APPLIANCE AS A MEANS OF FORCE CONTROL*

By James David McCoy, M.S., D.D.S., F.A.C.D., Los Angeles, California

IN PRESENTING this particular case for your consideration a definite request of the essay committee has been complied with; viz., that a typical instance be cited where the "open tube appliance" had been utilized as the corrective mechanism. For that reason no effort has been made to show an unusual case but rather one where the diversity of tooth movements so frequently required in treatment was carried out. To this end the following facts and the details which amplify them are submitted for your attention.

## DESCRIPTION AND ETIOLOGY

The patient was a boy thirteen years of age. At the time he came under observation he was in good health although his history among other things revealed the fact that in early infancy he had passed through a period during which he suffered from malnutrition. As this extended over a period of several years it seemed but logical to assume that it had been the predisposing cause of his maloccluding teeth. In view of the fact that he had for years been a habitual mouth-breather and in addition had suffered the premature loss of his mandibular second deciduous molars, the determining cause of the anomaly was chiefly attributed to these circumstances. Between his eighth and ninth years his tonsils and adenoids were removed, but normal respiration was not established at this time, for when he came to me for consultation he was still a mouth-breather. His maxillary dental arch was lengthened and narrowed and the incisors were protruding and otherwise the dental arch bore those characteristics which we find so frequently associated in those cases which have been subjected to malfunctioning facial muscles throughout the early developmental period (Fig. 1). The mandibular dental arch was shortened to such an extent that the mandibular second premolars had not put in their appearance and the mandibular incisors when the jaws were closed were in contact with the palatal mucous membrane.

## DIAGNOSIS

Sectional modeling compound impressions were obtained and casts of the denture completed. Radiograms also were made and showed the presence of the unerupted second mandibular premolars which were normal in development and apparently had been unable to erupt because of interference from adjacent teeth. The radiograms likewise revealed the presence of all four

*Case report read before the Twenty-sixth Annual Meeting of the American Society of Orthodontists, Chicago, May 2-5, 1927.

third molars, the mandibular ones showing a decided tendency toward impaction. A study of the denture in its relationship to the other facial structures led me to believe that this case was to be classified as a typical neutroclusion.

The extent of the changes necessary to restore the teeth and dental arches to a normal functional and anatomic relationship included the following: The upper dental arch required the buccal movement of the first molars, premolars and canines and the lingual movement of the incisors with a marked change in their inclination. In the mandibular dental arch there was required similar

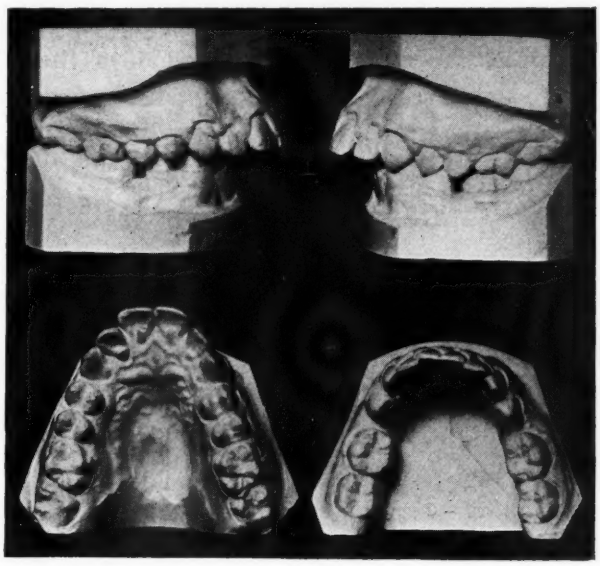

Fig. 1.—Dental casts before treatment showing the degree of malocclusion and general characteristics of the denture.

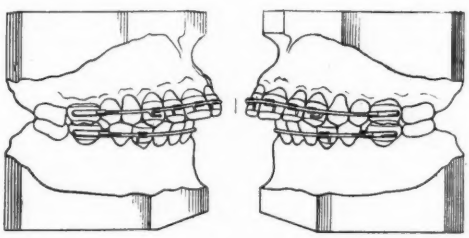

Fig. 2.—Complete appliances in place. These were used for the major part of primary orthodontic treatment.

movement with the buccal teeth, with a lengthening of the arch which should be sufficient in extent to allow for the eruption of the impacted mandibular second premolars. Changes also were indicated in the vertical relations of both maxillary and mandibular groups of teeth, particularly the incisors and molars, thereby establishing a correct overbite so that the opposing teeth might adapt themselves to a balanced functional relationship.

## MECHANISM EMPLOYED

In making and placing the appliances the following plan was carried out (Fig. 2). On the upper teeth precious metal bands were fitted to the first permanent molars which carried on their buccal surfaces round horizontal

tubes 0.35 of an inch in length and having an internal diameter suitable for the reception of threaded arch wire ends 0.036 of an inch in diameter. At the mesiolingual angle of each molar band, at a point which would lie close to the gingival margin, small eyelets or rings were soldered. Attachment bands were provided for the upper six anterior teeth, precious metal band material 0.14 of an inch wide by 0.004 in thickness being utilized. In fitting these bands an effort was made to have them occupy as high a position gingivally as was compatible with the health of the soft tissues. To this end, each band was festooned on its mesial and distal sides so that it would not encroach upon the structures in the interproximal spaces. Open tube attachments were soldered in the center of the labial surface of each of these bands and were so aligned horizontally that an arch wire could be seated into them readily. Lingual extensions were soldered to each canine band and carried back in such a manner that their ends hooked through the eyelets upon the lingual surfaces of the molar bands. After all bands were securely cemented the arch wire was attached as follows: A piece of wire 0.030 of an inch in diameter was soldered to a threaded end-section 0.036 of an inch in diameter

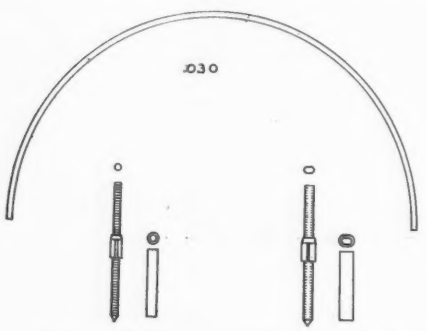


Fig. 3.—Threaded end sections of wire .036 of an inch in diameter for the construction of labial arch wires.

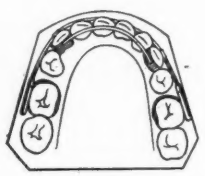

Fig. 4.—Appliances used on the mandibular teeth. The canine bands are connected with a soldered lingual wire establishing the mandibular six anterior teeth as a unit.

(Fig. 3). After the smaller wire had been thoroughly annealed, the threaded end-section with its adjusting nut set at a desirable point was inserted into the molar buccal tubing on one side and the arch wire adapted about the teeth, being so bent that it would lie in a passive state in each attachment. A threaded end-section was then inserted in the opposite molar buccal tubing and cut to such a length that its free end would engage the free end of the 0.030 wire forming the working portion of the arch wire. With this relationship established, both wires were removed from the mouth and the ends soldered together. The arch wire was then reinserted and modified until it would occupy a passive relationship in all its attachments. The open tube attachments were then gently closed down upon the arch wire through pressure exerted with a pair of flat-nosed pliers.

On the mandibular teeth, bands were likewise fitted to the molars and round horizontal tubes soldered on their buccal sides. Attachment bands were made for each mandibular canine with open tube attachments provided upon their labial surfaces. These attachments were soldered well down

toward the lower edge of the band which brought them quite close to the gingival margin. This was necessary to prevent the overlapping maxillary teeth from striking them. Before being cemented to place they were joined by a lingual wire which established all six of the anterior teeth as a unit (Fig. 4). A mandibular labial arch wire was then adapted, the same plan being utilized so far as its proportions were concerned as had been followed with the maxillary arch wire.

OPERATION OF APPLIANCES

After the patient had become thoroughly accustomed to the appliances the maxillary arch wire was removed and modified in form slightly, it being made more flat across the incisal segment and rounded in the region of the canines (Fig. 5). Its action, therefore, when locked back into position would be to exert pressure buccally upon the canines and the premolars through the lingual wire extensions, and with their movement bring pressure upon the incisors in a lingual direction. Small hooks were soldered to the labial arch wire at points just distal to each canine attachment to be utilized for intermaxillary elastics in case they should be needed to reinforce the mandibular

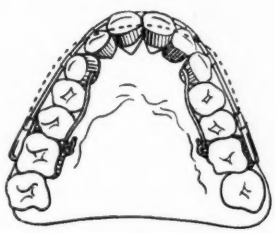

Fig. 5.

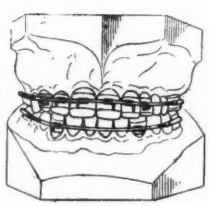

Fig. 6.

Fig. 7.

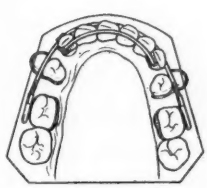

Fig. 8.

Fig. 5.—Showing the mechanical action of the upper labial arch wire when modified in form.
Fig. 6.—Vertical pins soldered to the arch wires at advantageous points.
Fig. 7.—Method of using vertical pins soldered to the arch wire for root and crown movement.
Fig. 8.—Method of using auxiliary springs for moving the mandibular first premolars in a mesial and buccal direction.

molars in their anchorage requirements. The horizontal portion of these hooks were extended to a point just past the center of each canine tooth and were made to rest against the lower edge of the bands. This was done with the idea of controlling the buccal movement of the canines so they would change bodily rather than be tipped during their movement. A similar means of control was utilized with the four incisors by soldering small vertical pins to the arch wire at points just distal to each attachment (Fig. 6).

In operating the appliances upon the maxillary teeth the form of the arch wire was gradually changed, being made to approach in form more and more the general contour and alignment which was desired in the maxillary dental arch. These adjustments were made every four weeks. Coincident with the increased width in the lateral portion of the maxillary dental arch the incisors were carried slightly lingually and given an alignment harmonious with the other dental arch proportions. During this movement their inclination was changed through the action of the little vertical pins soldered to the arch wire. This was effected by bending the vertical pins in such a manner that they were in contact with the labial surface of each incisor while

the arch wire was resting in contact with the lips of the open tubes. When carried within and firmly seated each attachment would, therefore, fulfill the function of a fulcrum with leverage exerted below them by the vertical pins (Fig. 7). This very effectually moved the incisal edges lingually while the roots were carried in a labial direction. It might be well in passing to state that in utilizing this mechanism great caution must be exercised in following out this plan, for unless the movement is carried out with care the root ends are apt to be carried too rapidly due to the efficiency of the mechanism.

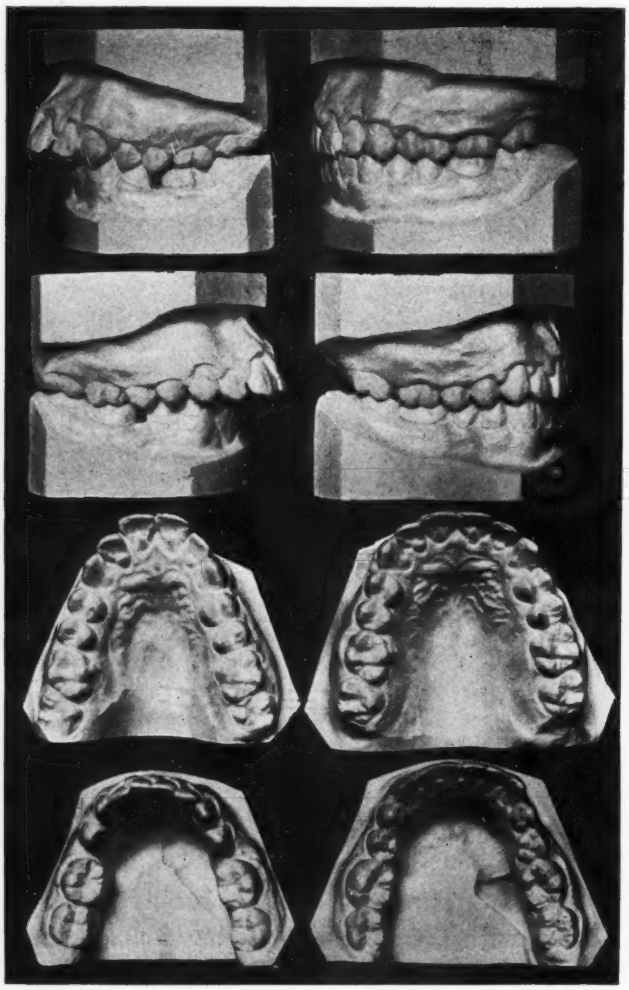

Fig. 9.—Dental casts showing several aspects of the denture before and after treatment.

Coincident with these changes in the upper dental arch the lower teeth were likewise moved. At first the only pressure which was supplied came from tightening the adjusting nuts on the arch wire. This effectually carried the lower six anterior teeth forward until sufficient space existed between the molars and canines for two premolars on each side instead of but one. No effort was made toward aligning the six anterior teeth for that was taken care of later. In order to render more efficient the action of the arch wire, small vertical pins were soldered to it at a point just distal to each canine band

attachment. By making it more secure in this manner it did not have the tendency to bow out in front of the lower teeth when pressure was exerted through the action of the adjusting nuts. In fact, that part of the labial portion lying between the cuspids was adapted close to the gingiva and in contact with the teeth so that its presence did not interfere with the lower lip or act as an obstruction to the brushing of the teeth.

The lower first premolars showed a tendency to follow the canines forward but this movement was not sufficient to properly place them mesiodistally or in a correct buccal relationship with the maxillary opposing teeth. These changes, however, were accomplished through the use of auxiliary springs, wire 0.020 of an inch in diameter being used. These were made in loop form, being soldered to the arch wire on each side at a point opposite the embrasure between the canines and the first premolars. In their formation they were first carried downward for about 0.25 of an inch, were then bent upward forming a round loop, and at a point just below the level of the arch wire were bent horizontally. This horizontal portion was allowed to extend in a lingual direction sufficiently so that it would encircle the distal and to some extent the lingual side of the tooth just above the gingival margin (Fig. 8). Before reinserting the arch wire these springs were bent in such a manner so that each premolar could be moved in a mesial and buccal direction. One adjustment only was necessary to effectually move these teeth into position and thereby provide spaces for the eruption of the mandibular second premolars. Fortunately this took place without delay. As soon as their eruption was well advanced, a complete change of appliances was made in the lower dental arch and the appliances used thus far were replaced by a removable lingual arch wire. With this appliance the alignment of the mandibular incisors was effected as well as a slightly increased width between the canines. Auxiliary springs were not used for this purpose, but the arch wire simply bent to the desired form and allowed to bear gently upon those teeth requiring movement.

Such changes in the occlusal plane as would favor the normal functional adaptation of the occluding teeth were effected as follows: In the maxillary dental arch an effort was made to depress the six anterior teeth slightly by making a sharp bend in the arch wire on each side just in front of the adjusting nuts. When placed back into the mouth it then occupied a gingival relationship to the open tube attachments and when locked in place would exert a depressing action upon these teeth and through its reciprocal action upon the molars would elevate them to some extent. In the mandibular dental arch this same character of force was exerted after the removable lingual arch wire was applied and through its action the necessary changes were effected.

Owing to the fact that this patient lived on a ranch at a considerable distance from the city, frequent visits were not possible. After the appliances were adjusted I had him come to the office every four weeks. The case was placed under primary treatment in September of 1919 and after nine months of orthodontic care the teeth and dental arches were established in a normal, functional and anatomic relationship (Fig. 9).

SECONDARY ORTHODONTIC TREATMENT

In order to restrain the teeth against any retrogressive changes and favor their more perfect adaptation in occlusion, secondary treatment appliances naturally had to be considered. In this connection it was deemed wise in the case of the maxillary teeth to utilize a Hawley appliance. Therefore, all fixed appliances were removed and a Hawley retainer was adapted. The patient was instructed to wear this at night only and in this he gave excellent cooperation. Upon the mandibular teeth a lingual arch wire was left in place for a period of several months after which it was removed and a canine-to-canine retainer put on. This precaution was taken due to the fact that a radiographic examination made at this time revealed a decided tendency on the part of the lower unerupted third molars to be impacted. Therefore, the lower dental arch was given protection in this region so that the alignment of the teeth would not be disturbed by the pressure from the impacted third molars. This plan of secondary treatment was continued for a full year, the patient being seen every ninety days for inspection. In the meantime the patient had acquired the habit of normal respiration which had been encouraged through the use of Roger's exercises, particular attention being directed toward the toning up of the orbicularis oris muscle. About this time the patient had the misfortune to lose his Hawley appliance and did not report the matter to me for several weeks. When he did so, however, the teeth showed no evidence of unfavorable changes and for that reason it was thought safe to get along without it. This decision proved correct and the maxillary teeth have never shown any tendency to revert to their original positions. Upon the agreement of the patient to have the impacted third molars removed, the mandibular canine-to-canine retainer was removed. Because of family illness and other diverting circumstances this agreement was not kept, and when I saw the patient last year they were still impacted and unerupted. The mandibular canine teeth on each side had become slightly rotated, their mesiolingual sides slightly overlapping the distal edges of the lower laterals. Other than this, however, the occlusal relations were satisfactory.

# Clinics

## A SIMPLE ECONOMICAL METHOD OF ORTHODONTIC PHOTOGRAPHY*

By Barney Kennedy, D.D.S., Jackson, Mississippi

WITH an ordinary kodak of suitable size, two portrait attachments, which may be obtained at any kodak shop at a cost of about a dollar each, photographs may be made of a definite size, for comparison, and in every way fulfill the requirements of the orthodontist.

The kodak may be put in definite focus for all times in the following manner: Extend the bellows to full length; take the lenses out of the portrait attachments, using a narrow paper shim between to prevent the two lenses from coming in contact, and put both in the same attachment being sure that the convex sides of both lenses are on the outside, and place on the lens of the kodak. See that the portrait lens is securely attached to the kodak lens and forced all the way home. Next open the stop all the way. Place indicator on time exposure to keep shutter open, then remove the back cover of your kodak. You are now ready to get your permanent focal distance at which all your photographs are to be made; no subsequent focusing will be necessary.

With a white piece of tissue paper placed on the back of the kodak in the position your film occupies and the lens shutter open, hold the kodak in the hands and focus on the filament of a stationary light bulb, moving the kodak back and forth to get the best image of the filament on the tissue paper. Now hold the kodak in this position and have your secretary measure the distance from the lens to the point of the light filament. This measurement may be made with a tape or yard stick and cut off and used in placing your patient this distance from the kodak; this distance will probably be between fifteen and twenty-four inches.

The time of exposure will have to be worked out, depending on your form of light. If natural light is to be used, the bulb exposure is recommended. Little difficulty will be experienced in working out this part of the technic.

This method of making your own photographs is simple, inexpensive, definite, and a time-saver for the busy orthodontist.

*Clinic presented before the Twenty-sixth Annual Meeting of The American Society of Orthodontists, Chicago, May 2-5, 1927.

## *DEPARTMENT OF*

# *ORAL SURGERY, ORAL PATHOLOGY AND SURGICAL ORTHODONTIA*

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## SURGICAL TREATMENT OF A CASE OF ACUTE OSTEOMYELITIS OF THE MANDIBLE

By Sterling V. Mead, D.D.S., Washington, D. C.

MR. D. C., aged forty-eight, a government clerk by occupation, was referred to me December 29, 1927, by his dentist after removal of infected mandibular left third molar roots, and opening into area of chronic osteomyelitis about the roots. His physical condition was not good, and he was in great pain. His temperature was 102° F. He stated that he had had

Fig. 1.—Roentgenogram showing roots in lower third molar region and chronic osteomyelitis.

tuberculosis in 1908 and in 1921, and had several lung hemorrhages. He had been obliged to go to sanitariums on these two occasions. As long as he could remember he had had trouble with the mandibular left third molar.

A roentgenogram showed a rarefied area in the mandibular left third molar region.

He stated that in 1924 a dentist attempted to remove the mandibular left third molar and two roots were left in the bone. He had considerable trouble at that time. In 1925 he developed neuritis of the left arm. He had always had discomfort in the left mandible, and since the molar was removed, he had had continual soreness and dull pain in this region, and the sensation of swelling.

Fig. 2.—Photograph showing rubber tube for through and through drainage.

Fig. 3.—Roentgenogram showing tube in the tissues, lying closely against the ramus.

Upon receiving Mr. C. for treatment from his dentist, after removal of the roots and residual infection, the wound was irrigated frequently with saline solution. An acute cellulitis developed as well as a peritonsillar abscess. The peritonsillar abscess was lanced and hot magnesium sulphate packs were applied to the face. Because of his apparent low resistance, his physician endeavored in every way to better his general condition. He was, of course, confined to the hospital. His temperature was running a septic course from 101° to 104° F., and he was extremely ill, and in immediate danger.

A culture was made from the pus obtained by incision, which showed streptococcus viridans in pure culture. Vaccine was prepared and given, and this was continued over a period of two months. He was given nourishing

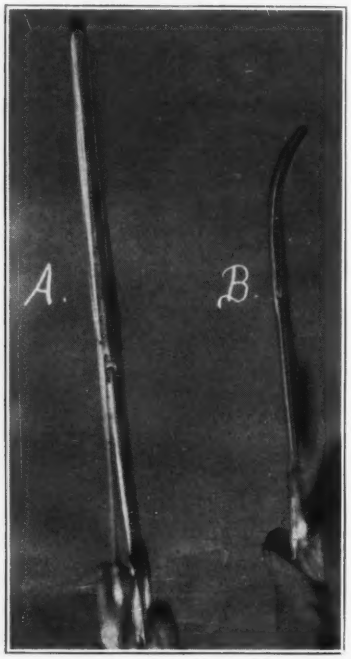


**Fig. 4.**—Photograph showing: *A*, Hemostat designed by writer for pulling rubber tubing through incision shown in Fig. 2. *B*, Curved hemostat used for spreading tissues.

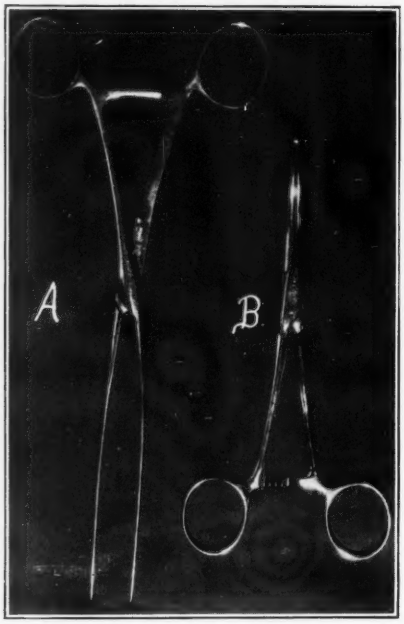


**Fig. 5.**—Instruments shown in Fig. 4; *A*, Special hemostat. *B*, Curved hemostat.

food, orange juice, and plenty of liquids, including whisky and eggs. He was given cod-liver oil emulsion and chlorine. He was also started on a series of actinic-ray treatments. The peritonsillar infection yielded to incision and drainage, but the cellulitis and infection about the third molar area persisted. The infection worked up under the masseter muscle toward the condyle, and intraoral and extraoral incision failed to stop it. After each incision, of course, the wound was spread with a hemostat and a fenestrated rubber tube inserted. Because of the chronic osteomyelitis being shown in the roentgenogram about the third molar roots before removal, an acute attack of osteomyelitis was expected and showed up early in the extraoral roentgenograms. The extreme susceptibility of the patient, and the variety of complications, necessitated placing a through and through drain.

An incision was made under the inferior border of the zygoma, the wound was spread with a curved hemostat, and the hemostat run down under the parotid gland, following closely the bone. An incision had previously been made for drainage, about one inch below the angle of the jaw. This was

Fig. 6.—Roentgenogram of mandible showing acute osteomyelitis, Fig. 10.

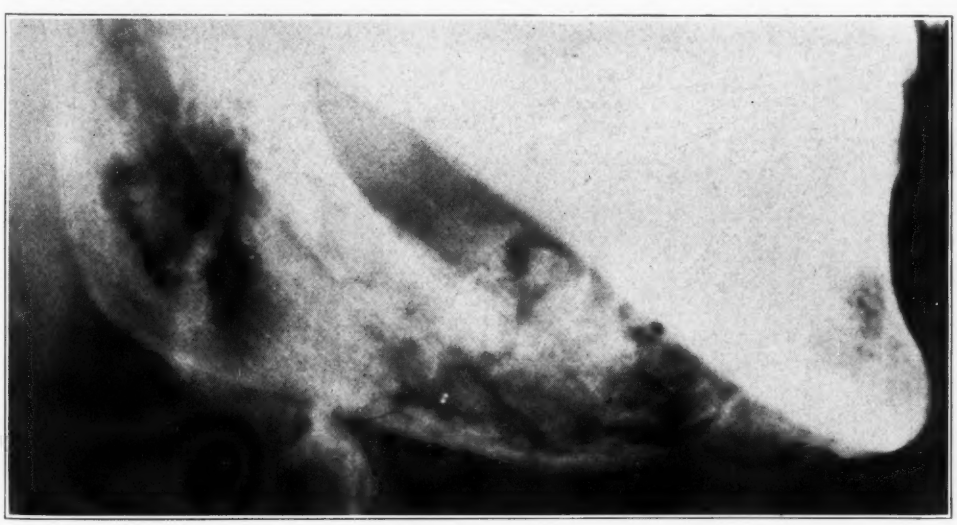

Fig. 7.—Roentgenogram made February 16.

reopened and a curved hemostat pushed upward, following the bone closely until it touched the point of the hemostat inserted from above. The upper hemostat was removed and a special hemostat (Figs. 4-*A* and 5-*A*,) having a long, strong wide beak, was inserted and pushed entirely through the open-

ing, following the lower hemostat as it was removed. The peaks of the long special hemostat were pried open and a rubber drain tube was pushed over one peak and the hemostat clamped onto it. It was then pulled upward

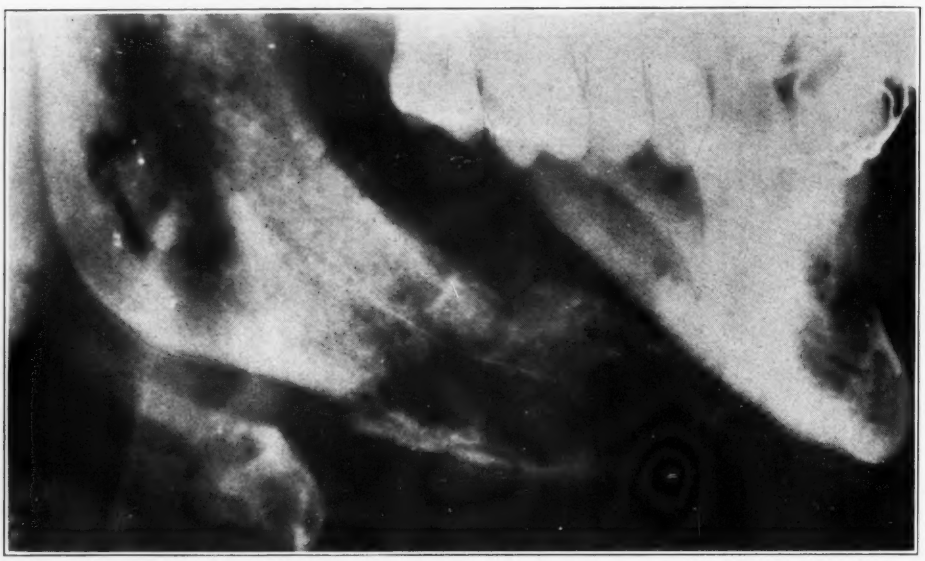

Fig. 8.—Roentgenogram made February 18, showing sequestrum in ramus and fracture of mandible, with beginning sequestration in bicuspid and molar regions.

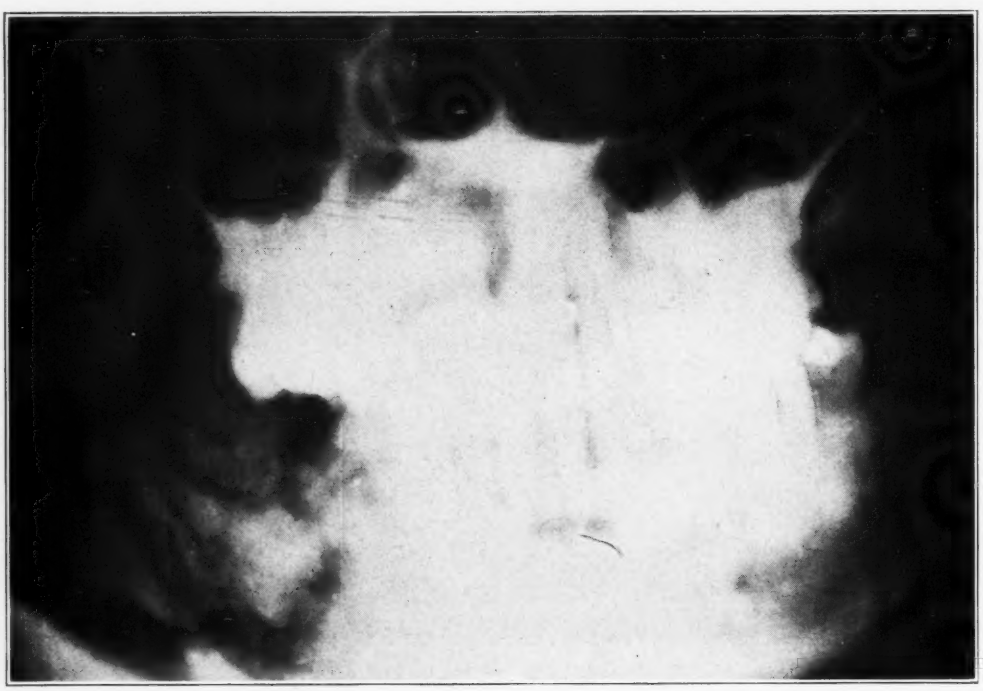

Fig. 9.—Anteroposterior roentgenogram, made February 24, showing fracture and osteomyelitis.

through the opening. A smaller tube was then perforated or fenestrated and pushed through the larger tube and the larger tube removed, leaving the smaller tube in place. This gave a method of through and through drain-

Fig. 10.—Lateral extraoral roentgenogram made February 24.

Fig. 11.—Roentgenogram made March 26, after removal of sequestrum in ramus and removal of segment of inferior border of mandible.

Fig. 12.—Roentgenogram made April 2.

age. A 5 per cent mercurochrome solution was put into the upper opening of the tube and drainage occurred both into the mouth and through the lower opening of the tube. The acute soft tissue involvement was in this way soon controlled and the tube removed. The acute osteomyelitis was treated by drainage through the mouth wound, out through the extraoral incision. Aromatic chlorazene or saline solution was used with a metal syringe.

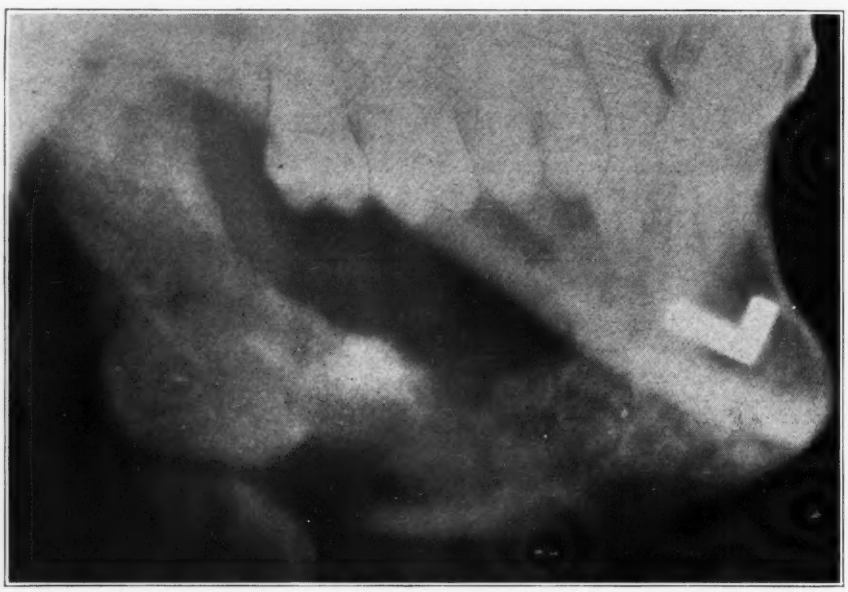

Fig. 13.—Roentgenogram made April 16, showing bone regeneration.

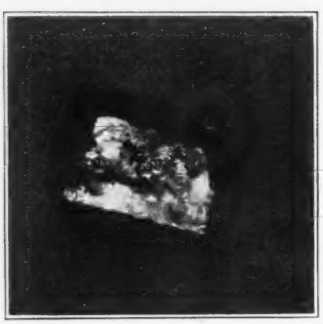

Fig. 14.—Photograph of sequestrum removed from ramus.

The accompanying photographs show the progress of the bone destruction and the spontaneous fracture of the mandible in the bicuspid region. There was no surgery done, except to remove loose or involved teeth and to remove sequestra as they formed. The sequestrum in the angle of the jaw was removed through the extraoral incision, as well as a piece of the inferior border of the mandible. Another large sequestrum was later removed from the bicuspid area through the mouth wound. A culture of the pus at the time the sequestrum was removed from the angle of the jaw showed bacillus mucosis capsulatus (predominating) and Streptococcus viridans. An inter-

Fig. 15.—Photomicrograph (x 20) of sequestrum shown in Fig. 14.

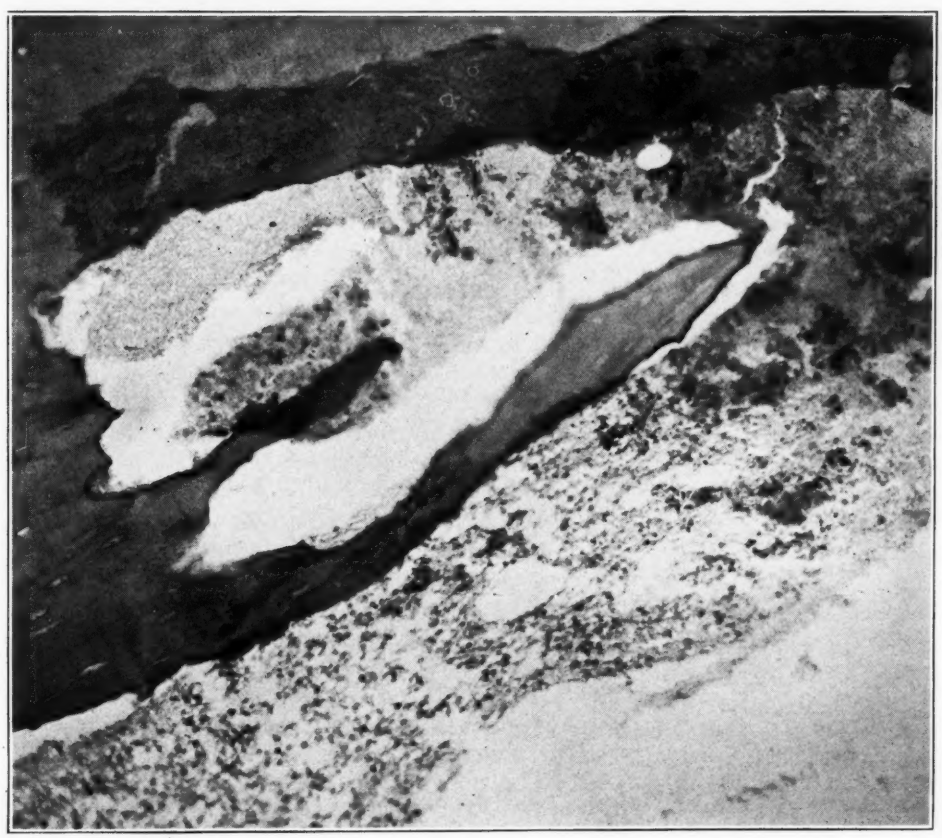

Fig. 16.—Photomicrograph (x 145) of sequestrum shown in Fig. 14.

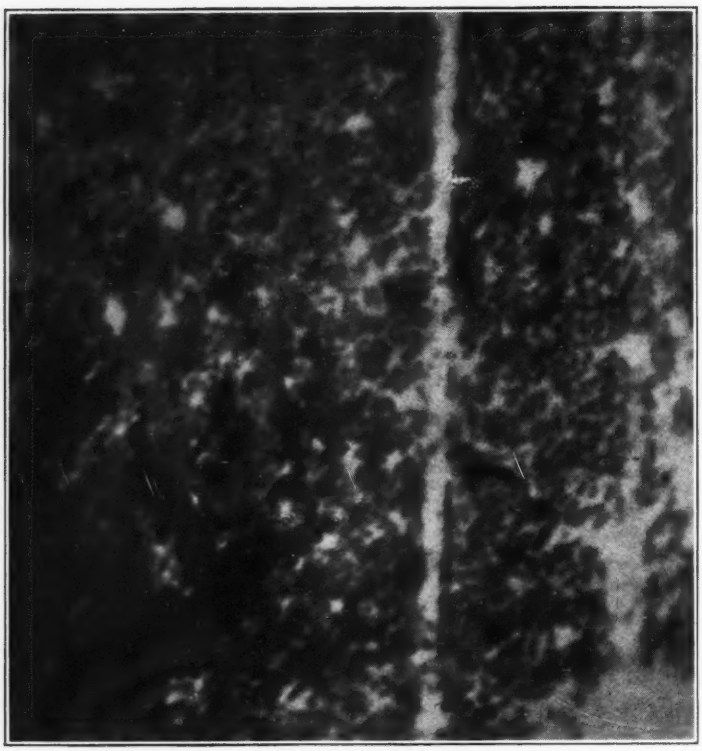

Fig. 17.—Photograph of section of sequestrum shown in Fig. 14 (x 2280), showing bacteria.

maxillary splint had been made in anticipation of the fracture, but intermaxillary wiring proved sufficient to keep the parts in proper position.

On May 1, four months after the onset, the intermaxillary wires were removed, and the patient was allowed to commence to use the jaws, as union of the parts had taken place and calcification was progressing rapidly.

# CLINICAL ORAL SURGERY*

By Theodor Blum, D.D.S., M.D. (Penn.), New York City
*Universal Medicinae Doctor (Vienna), F.A.C.D., F.A.C.S.*

THE author, being mainly a clinician, cannot be expected to write a paper on the pathology or bacteriology of the subject he wishes to present. On the contrary, it will be a report of a small number of interesting cases with which to emphasize certain points of importance to the practitioner in daily routine work. It so happens that all the cases cited give the writer an opportunity to recommend particularly one main thought in the treatment of our patients, namely, conservatism.

## OSTEOMYELITIS

Case 1.†—Osteomyelitis of the mandible. F. S., female, aged 8, February 24, 1926.

*Chief Complaint.*—Pain and swelling of mandible from angle to angle. About six weeks ago, the patient had a toothache (left mandible) and the face became swollen. The physician advised hot applications externally but the swelling spread. An x-ray showed a honey-comb condition of the bone (Fig. 1). External examination showed a swelling from angle to angle of the mandible but without redness externally. The submaxillary gland was swollen and sensitive. The teeth between $\overline{6}|$ and $|\overline{3}$ were loose and pus was exuding from this space. All mandibular teeth were loose; on the right buccal side, there was fluctuating swelling. The floor of the mouth was also swollen with very little redness. The patient could open and close the mouth easily. February 24, 1926, the patient was admitted to the hospital with a temperature of 101.6° F. and blood count of 2,760,000 red cells and 6,450 whites. The next day, under gas and ether anesthesia, the soft tissues on the buccal side were stripped off to afford better drainage and all deciduous teeth anteriorly to $\overline{6}|\overline{6}$ were removed. The bone was necrotic but not sequestrated. Dressings were changed at intervals of forty-eight hours and two weeks later the patient left the hospital. Two weeks after her discharge from the hospital, the patient presented herself with a swelling and tenderness in the left mandibular region. Blood count showed 4,100,000 red cells and 20,800 whites. Patient was readmitted to the hospital on March 26, 1926, when an external incision was made at the angle of the left side of the mandible. Nine days later a large sequestrum was removed. At intervals of a few days, several small sequestra were removed from the left side of the mandible and about ten days later the right side of the face became swollen and the patient was again placed in the hospital. An external incision was made under gas and ether anesthesia (April 28, 1926), at the right mandibular angle and a large amount of pus drained. The submaxillary and superior cervical glands were found to be involved and these were drained. Several small sequestra were also removed. At the same operation, the old incision on the left side was enlarged and additional sequestra removed. At intervals, sequestra were removed for the next six months when the patient was again placed in the hospital and under gas and ether (November 5, 1926) the anterior border of the left ascending ramus was opened and three large sequestra comprising the coronoid and condyloid

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†The histories reported in this paper were compiled from hospital and office records by Dr. Robert M. Fischer.

processes removed. The left second molar and germ of the third molar were also removed. Since the last operation, the patient has shown marked improvement and one week ago the pulp test showed all remaining mandibular teeth were vital except $\lceil\overline{5}$ which is doubtful (Fig. 2).

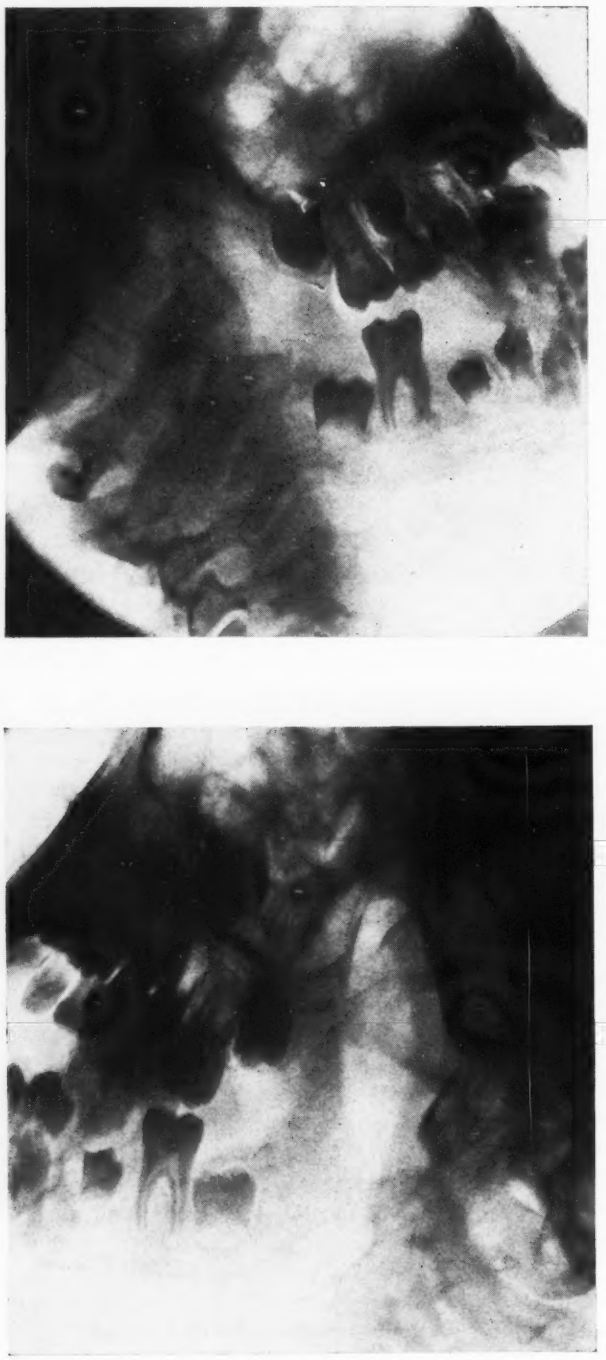

Fig. 1.

Osteomyelitis of the mandible or maxilla is a splendid example of a condition in the treatment of which anything but conservatism is disastrous.

Free drainage and watchful waiting are indicated. Wherever pus is found, a surgical incision is made; whenever bone is separating as a sequestrum, it is removed.

Occasionally an osteomyelitis is produced by an early incision and curettage in case of an acute periostitis, which without surgical interference would most likely have disappeared in due time. Curettage of painful and of so-

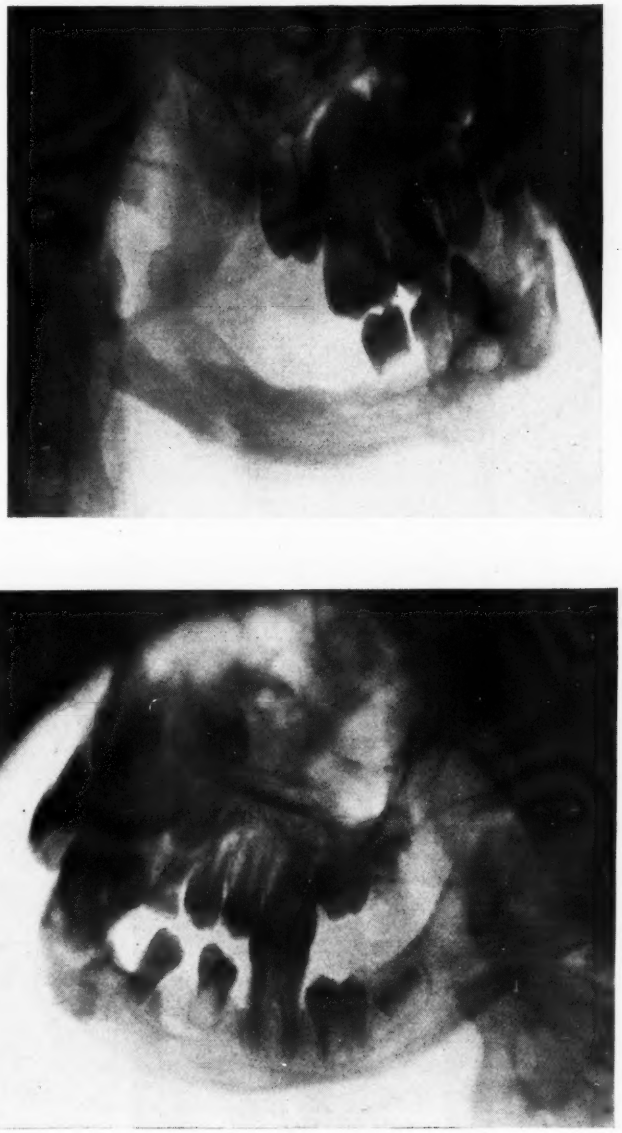

Fig. 2.

called dry sockets is frequently followed by infection of the surrounding bone, ending in the formation of sequestra.

Many teeth can be saved during the treatment, especially permanent ones even though not fully developed. Assuming the responsible tooth has been removed, one should not hurriedly sacrifice all loose teeth—as most of them

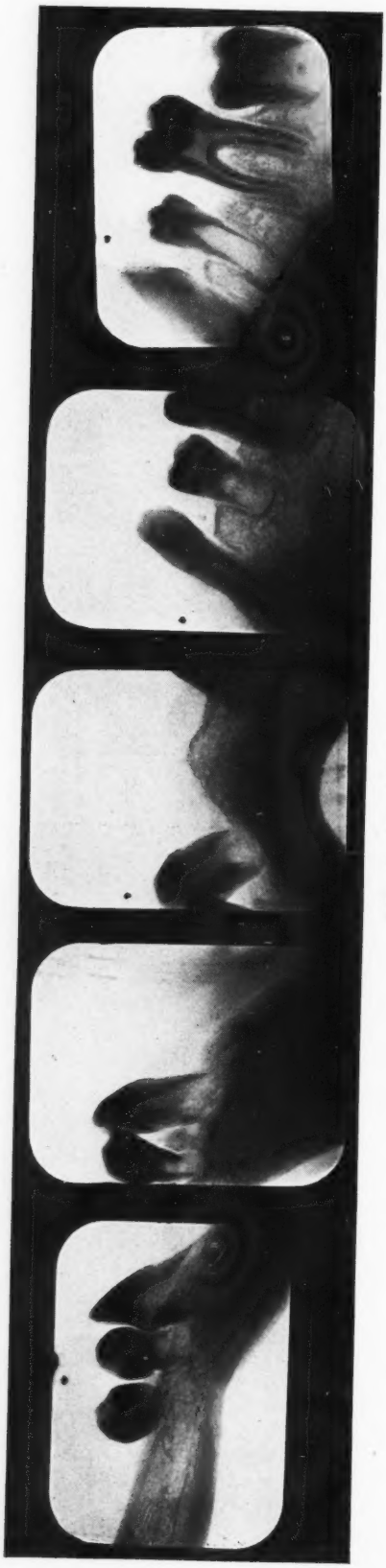

Fig. 2. (Continued.)

will be during the acute stage—but rather wait for the subsidence of the acute symptoms, after which quite a few will become firm and continue to develop to become useful members of a damaged masticating apparatus.

When the condyle and neck of the ascending ramus have been sequestrated in growing patients, shortening of the affected side can be largely prevented by continuous and faithful exercise. This consists of opening and closing the jaws either straight up and down or preferably somewhat toward the sound side and also keeping the closed jaws in proper (normal) occlusion. This exercise performed three times daily sufficiently stimulates the parts to new bone formation and restores fairly normal function.

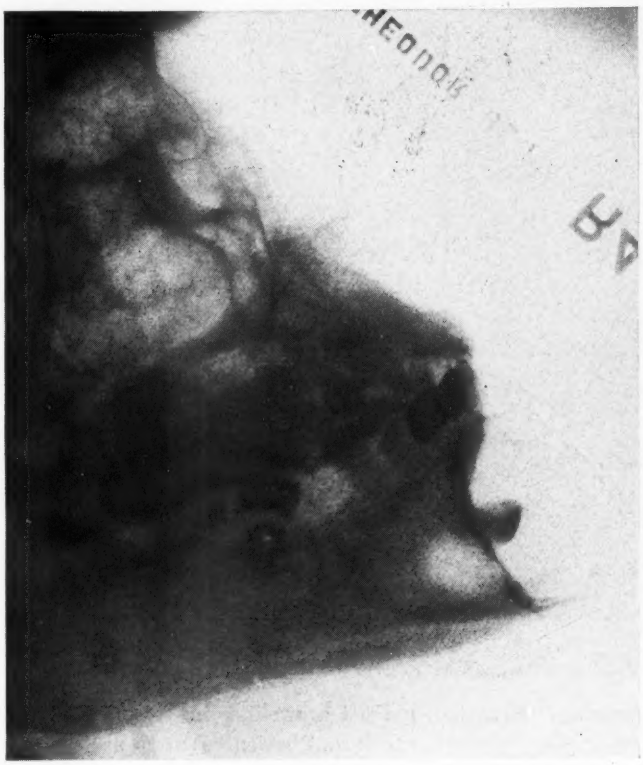

Fig. 3.

FOLLICULAR CYSTS

CASE 2.—Follicular cyst (originating from $\overline{3}|$). M. G., male, aged 33 years, November, 1918.

*Chief Complaint.*—For the past ten or fifteen years the patient has had a slight swelling in the mouth, but no pain. Recently some teeth were extracted and a few days ago the mandible commenced to swell. The patient also complained of considerable pain, which was also quite recent. The profile had the appearance of prognathism, although the bite was normal, due to the extension and distension of the outer cyst wall (Fig. 3). There was fluctuating swelling from $\overline{6}|$ to $|\overline{5}$ inclusive and $\overline{3}|$ was missing. Upon aspirating and then incising, a large amount of cyst fluid containing cholesterin crystals, polynuclear leucocytes and fat globules was washed out. Blood and urine negative.

Operation, on November 25, 1918, right and left mandibular and buccal infiltration were given. Incision was made about ½ cm. below the gingival border from $\overline{6}|$ to $|\overline{6}$ and outer plate and cyst wall removed; $\overline{3}|$ (unerupted) was also removed (Fig. 4). On the right side the cyst extended to the mandibular canal exposing about one inch of this nerve and the mental branches (Fig. 5). The cyst membrane in this region was removed to allow a clot to form around the nerve. The inner half of the cyst membrane was left intact as were all the teeth (Figs. 6 and 7).

CASE 3.—Follicular cyst (originating from $|3$). A. L., male, aged fifty-two, April, 1924.

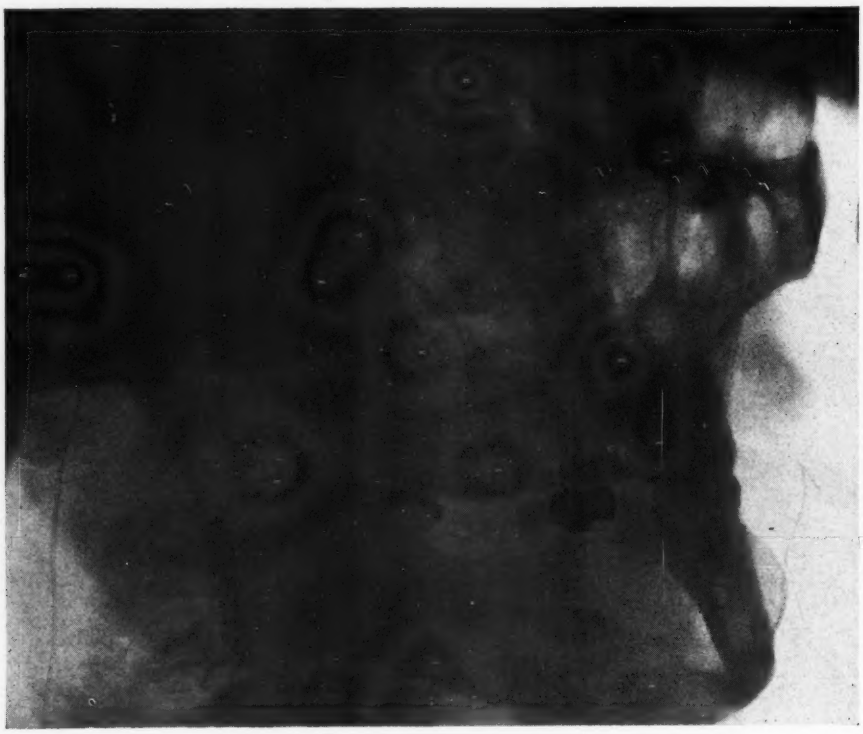

Fig. 4.

*Chief Complaint.*—Patient had noticed a swelling in the mandible for some time. Two weeks ago, the barber called attention to it and patient went to dentist who advised operation.

The outer plate of the mandible, extending from $\overline{7}|$ to $|\overline{7}$ bulged markedly. The skin and lower border were normal. $\overline{4}|$ and $|\overline{3}$ and $|\overline{6}$ were missing. Practically the entire lower buccal fold was obliterated by the bulging of the outer plate. There was a parchment-like crepitation of the protruding plate. Pulp test showed $\overline{4.3}|\overline{5}$ nonvital. Blood and urine negative.

Operation, April 11, 1924, a bilateral mandibular anesthesia was given and also buccal infiltration. Several c.c. of dark red brown fluid were aspirated in region of $\overline{3}|$. Incision was made at the lowest point of the firm attachment of the gingiva from molar region on the right to molar region on the left. Outer plate was removed with cyst membrane attached to it, revealing a cyst cavity containing a soft, pasty mass of cholesterin crystals and considerable reddish brown fluid (Fig. 8). $|\overline{3}$ which caused the cyst was found lying horizontally along the lowest part of the cyst and had to be chiseled from the lower border of the mandible to which the cyst cavity extended. The wound was packed with iodoform gauze without disturbing the remaining cyst membrane and the flap was folded in.

One month after the operation all the teeth from $\overline{6}|$ to $|\overline{7}$ were found to be nonvital and were then treated and the roots filled (Figs. 9 and 10).

CASE 4.—Follicular cyst (originating from $|\overline{3}$). M. R. C., male, aged forty-six, July, 1926.

*Chief Complaint.*—Patient complained of tenderness and swelling in the anterior part of the mandible. When thirteen years old, the patient struck his chin while playing. A few years ago a spot tender to touch was discovered in the chin. There was a slight swelling in the left mental region. $\overline{5}|$ and $|\overline{3}$ were missing. There was a marked swelling labially from $\overline{2}|$ to $|\overline{5}$ inclusive and also lingually. There was also fluctuation from the buccal side through to the lingual in the apical region of $\overline{6}|$ and $\overline{5}|$. Blood, urine and Wassermann negative.

Fig. 5.

Operation, September 22, 1926, conservative cyst operation was performed removing only malposed $|\overline{3}$ (Fig. 11). Columbia pulp test July 23, 1926 showed the following:

| 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| + | + | **M** | + | + | + | + | + | + | + | **M** | + | + | + | + | + |
| 25 | 25 | | 25 | 25 | 25 | 40 | 40 | 40 | 40 | | 25 | 25 | 25 | 25 | 25 |

(Fig. 12)

The central and lateral incisors responded at a higher index indicative in this case of marked pulpal changes though not devitalized. Cameron pulp test December, 1926, showed the following:

| 7 | 5 | 4 | 3 | 2 | 1 | 1 | 2 | 3 | 4 | 5 | 6 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 31 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 |
| +7 | +7 | +5 | +6 | +9 | +10 | +8 | +7 | M | +7 | +7 | +6 |

All teeth respond in varying degrees as indicated. 10 is a very low response as compared with 7 or 6.

Radicular and follicular cysts are treated either radically or conservatively. Only in the larger cysts—particularly the ones adjoining the antrum or nasal chambers—the conservative treatment is employed, namely, the removal of the outer plate of bone and cyst wall, leaving the inner cyst wall in position; in other words, transforming the cyst cavity into a shallow accessory cavity of the mouth.

Fig. 6.—Condition of jaw 8 years 4 months after operation.

Fig. 7.—Condition of jaw 8 years 4 months after operation.

A considerable number of follicular cysts develop from malposed mandibular canines. In these cases most of the teeth in the region of the cyst have remained vital and therefore can be saved (Fig. 13). If the apices extend into the cyst cavity or are likely to be injured at the time of the operation, their root canals should be filled before and their apices amputated at the time of the operation (see Fig. 9). After the operation the vital teeth

should be pulp tested at regular intervals on account of the possibility of loss of vitality due to injury during the operation.

It may not be out of place to mention here the case of a follicular cyst originating from a supernumerary tooth located in the wall separating the cyst from the antrum. The two cavities were communicating, an extremely

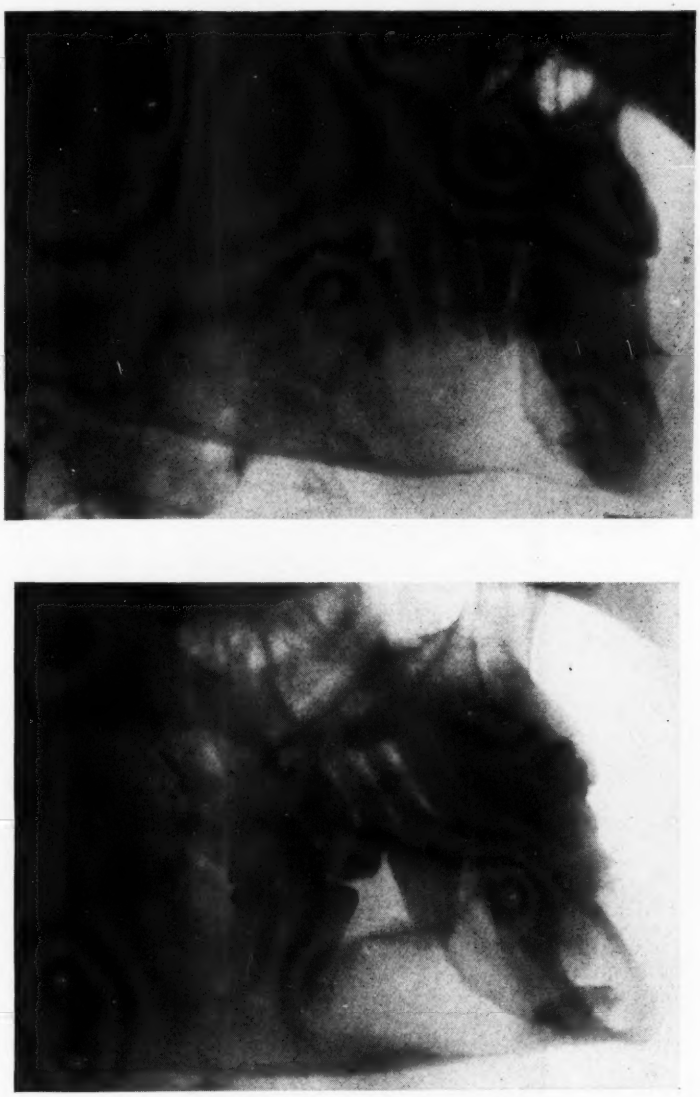

Fig. 8.

rare occurrence, due to an acute infection in the cyst, the contents of which broke through the point of least resistance—in this instance through the thin membranous wall above mentioned—into the antrum.

### MULTILOCULAR CYSTS

CASE 5.—Multilocular cyst (right side of mandible). H. W., male, aged thirty-six, December 14, 1918.

*Chief Complaint.*—Swelling of right side of face. When patient was one and one-half years old, he had a swelling on the right side of the neck. This was operated upon, but

Fig. 9.—Condition of jaw 2 years 11 months after operation.

recurred sixteen years later. He again underwent an operation and for twenty years had no further trouble until six months ago when a swelling appeared in the same region. A tooth was removed without helping the condition—in fact the swelling became larger. The x-ray revealed a cyst (Fig. 14).

The face was swollen in the region of the right angle of the mandible. There was a sinus through the socket of $\overline{7}|$ discharging a brownish fluid. The swelling was very hard. This was operated upon December 20, 1918, under ether and the cyst curetted. The inner and outer plates of the ascending ramus and the body up to $\overline{4}|$ were entirely gone. The patient left the hospital one week later and was discharged a few months later (Fig. 15).

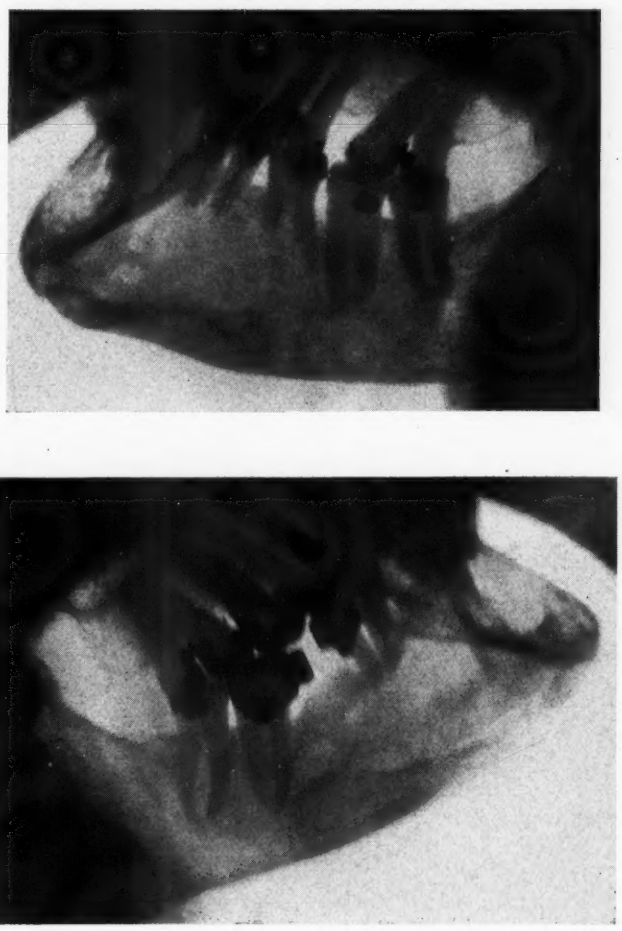

Fig. 10.—Condition of jaw 2 years 11 months after operation.

Approximately four years after the last operation, the patient returned with pain and swelling in the same region as before. Externally the appearance was normal except for a slight fulness over the masseter muscle. Intraorally there was a mass about 2 cm. long and 1½ cm. wide in the retromolar triangle region. The mass was movable and cartilage-like and the mucous membrane over it normal.

Two months later the anterior border of the ascending ramus presented marked fluctuation and the area previously noted had enlarged considerably. Under general anesthesia (May 17, 1923) an incision was made along the anterior border of the ascending ramus to the region of $\overline{6}|$ and a large part of coronoid process as well as alveolar process in the region of $\overline{8\text{-}7\text{-}6}|$ removed. The cystic area was completely curetted. The wound was partly sutured and packed. Two weeks later radium treatment was commenced and up to

the present there has been no recurrence, although a suspicious area in the right horizontal ramus will be kept under observation (Fig. 16).

CASE 6.—Multilocular cyst (right side of mandible). B. M., female, aged twenty-seven, June 12, 1919.

*Chief Complaint.*—Swelling of the right side of the face.

Fig. 11.

One year ago, the patient felt something snap in the right side of the mandible while eating, but ignored it. Eight months later, she visited her dentist who removed a tooth and some growth in the same region. A swelling resulted, whereupon she consulted a general surgeon who aspirated some fluid from the region of the swelling, but the swelling continued to increase. There was no pain except at night. Fluid and a section of the growth taken from the first molar region of the right side of the mandible were diagnosed microscopically as cyst fluid and adamantinoma, respectively. A large incision was made in the region of

Fig. 12.

Fig. 13.

the ascending ramus to relieve the swelling and establish drainage. The patient was admitted to a hospital two months later where, under gas and ether (June 4, 1919), an intraoral incision was made and the entire cyst membrane curetted (Fig. 17). Dressings were changed at forty-eight hour intervals and Dobell's solution used as a mouth wash. Three weeks later the x-ray revealed small cystic areas in the anterior part of the affected region (Fig. 18) and three months later definite signs of recurrence were seen. Eight months after the first operation, the patient was again placed in a hospital and on February 6, 1920, under local anesthesia (mandibular and buccal), the cyst membrane was curetted and iodoform gauze dressings inserted. The specimen was again diagnosed as multilocular adamantinoma.

Fortunately later on, the specimen removed from the cyst by a previous operator was obtained for microscopic examination. It showed an arrangement of cells very much resembling the solid adamantinoma (Fig. 19).

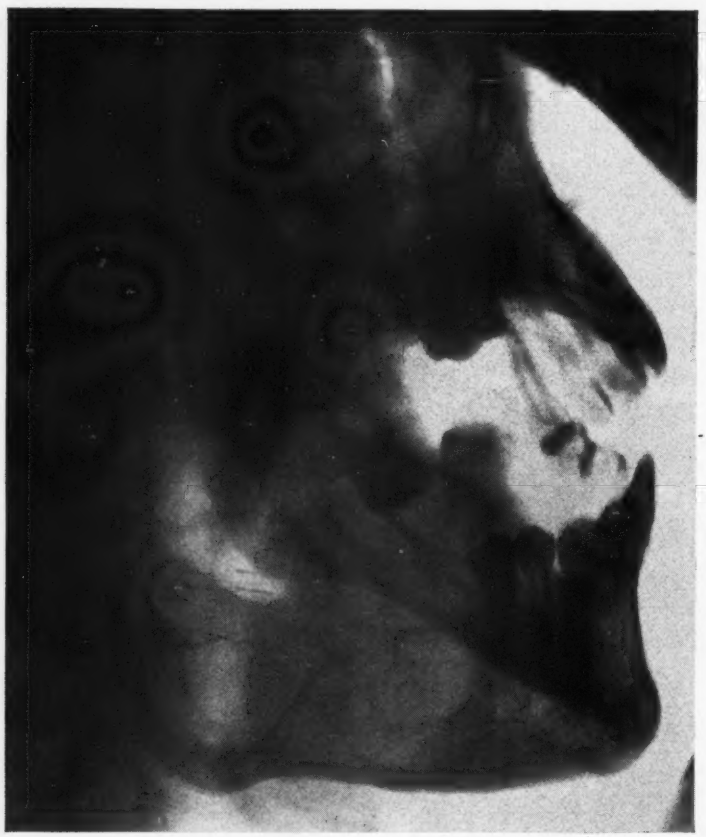

Fig. 14.

CASE 7.—Multilocular cyst (adamantinoma, left side of mandible). A. S., male, aged forty-nine, October, 1925.

*Chief Complaint.*—Patient complained of swelling of left side of face in the region of the mandible. Seventeen years ago patient had swelling of the same region accompanied by pain. At that time cystic fluid was aspirated from the jaw. Patient has had five operations since. About three years previous to the onset of the swelling $\lceil 8$ was extracted.

The patient presented himself with a swelling extending from below the zygoma on the left side to the lower border of the mandible and forward to within 1 cm. of the side of the nose. The skin was normal. Intraorally the swelling began in the region of $\lceil 6$ and extended lingually and buccally back to the anterior pillar of the fauces. It was covered by normal mucous membrane except in one place along the ridge where there were some

granulations. There was marked fluctuation (Fig. 20). Blood, urine and Wassermann negative. Patient was placed in a hospital and under general anesthesia (October 14, 1925), an external incision was made and the buccal wall of the mandible removed, membrane curetted and remainder of the cavity cauterized.

Fig. 15.

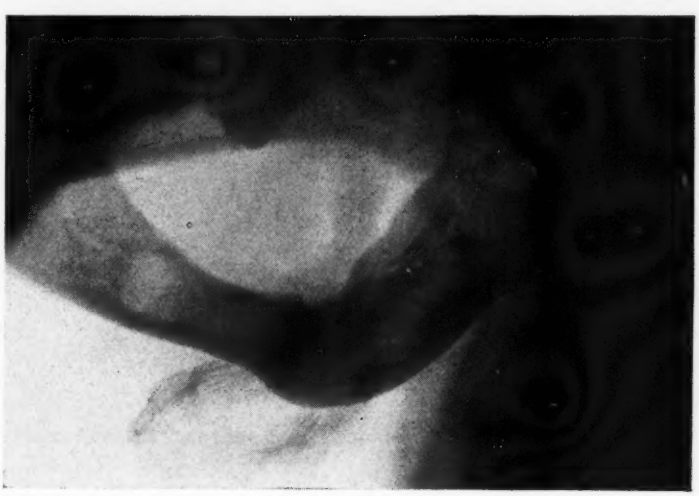

Fig. 16.

Following this operation a thin fluid was noticed constantly present in the wound. One month later a fluctuating mass 3½ cm. by 2½ cm. was noticed along the left mandibular ridge in the premolar region. Eleven weeks later, under local anesthesia, this was incised and a cyst exposing the mandibular dental nerve and its mental branches was curetted (Fig.

21). One week later, the patient was referred for radium treatment after another section had been examined and diagnosed as adamantinoma.

At present (March 22, 1927), there is a very noticeable fluctuating swelling in the left cheek just anterior to the ascending ramus and between the mandible and maxilla, all pointing toward a recurrence (Fig. 22).

Fig. 17.

Fig. 18.

The treatment of multilocular cysts is radical, which means that every part which is visible to the naked eye must be removed. At intervals of from six months to one year, the affected jaw must be reexamined and x-rayed again and, if found diseased, reoperated upon. It is then not a recurrence, but the continued growth of formerly invisible cysts.

If a multilocular cyst cannot be eradicated by operation alone on account of extreme involvement of bone and soft tissues, then an operation should be performed first and as much of the cyst as possible removed, without disfigurement of the patient and without loss of function, followed by the use of radium, the success of which has been shown in two cases reported above. At any rate, this treatment should be given a trial.

In one case reported, the simultaneous occurrence of a solid adamantinoma in the middle of a large multilocular cyst strengthens the author in his belief that the two are in reality one pathologic condition.

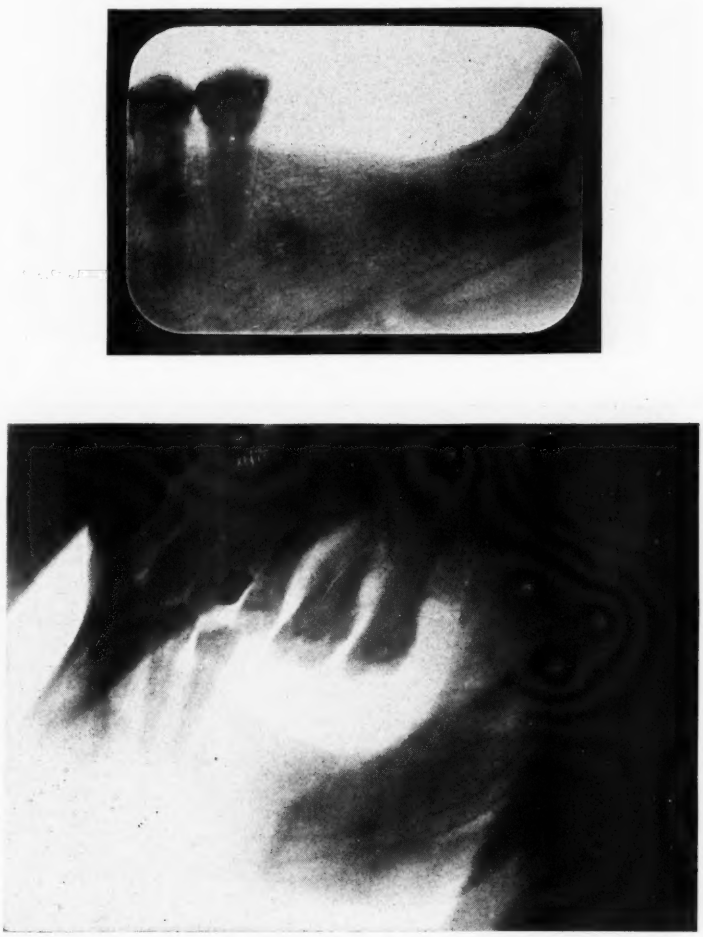

Fig. 19.—Condition of jaw 7 years after operation.

While the majority of cases are found in the mandibular angle, the author has also encountered one in the horizontal ramus and other observers have seen them in the maxilla.

The wisdom of persistent regular reexamination cannot be denied and must be impressed upon the patient with great emphasis.

### MALIGNANT TUMORS

CASE 8.—Epidermoid carcinoma (left side of the mandible). E. H., female, aged thirty-seven, September 13, 1921.

*Chief Complaint.*—Swelling in the region of the left side of the mandible. Two years ago the left side of the face began to swell, increasing gradually in size but without pain. There was a swelling extending from just anterior to the angle of the left side of the mandible to the angle of the mouth. The swelling does not extend below the lower

Fig. 20.

Fig. 21.

border and the skin over it was normal. The soft tissues were movable but a hard lump approximately 5 cm. long and 2½ cm. high could be felt. Intraorally there was a mass about 1½ cm. anteroposteriorly along the alveolar ridge and 1 cm. wide, which had a cauliflower appearance, but was hard and not very vascular. The tumor extended down to the mylohyoid ridge. The crowns of the teeth in the maxilla struck this mass when the mouth was closed (Fig. 23).

Blood, urine and Wassermann negative.

Under local anesthesia, November 15, 1921, an incision was made in back of the posterior extremity of the tumor, starting at the anterior border of the ascending ramus and extending forward through the buccal mucous membrane to the premolar region. The incision was continued lingually, but not connected posteriorly. Just posterior to the mental foramen, the mandible was divided with a Gigli saw, but the posterior part of the tumor had to be chiseled out en masse. Sutures and a packing were inserted and the jaws wired together.

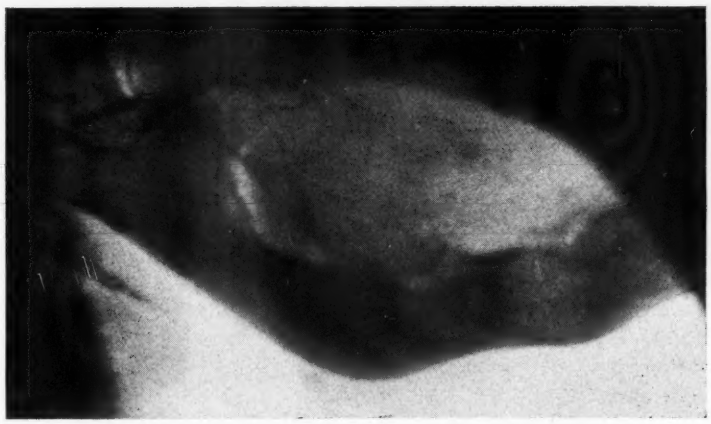

Fig. 22.

Fig. 23.

The specimen was diagnosed as epidermoid carcinoma. (Epithelioma.)

Two weeks later, radium treatment was commenced. Three weeks after the operation pus appeared below the middle of the lower border of the mandible and twenty days later, a sequestrum was removed. Eleven weeks after the operation the wires were taken off. There was no recurrence (Fig. 24).

While the treatment of malignant tumors must necessarily be radical, still a certain group of cases can be taken care of, apparently successfully, without disfigurement or loss of function. More can be accomplished by radium and x-ray followed by operation than any other method known to the author. Carcinomas of the mucous side of the cheek, the floor of the mouth,

Fig. 24.—Condition of jaw one year 2 months after operation.

Fig. 25.

others beginning at the mucous membrane covering the alveolar ridge and involving the bone, etc., have remained without recurrence for at least four years, and—*nota bene*—without having undergone operations, the results of which would have kept the patient secluded on account of the disfigurement and made him miserable on account of loss of function.

This treatment of malignancies of the oral cavity, consisting of radium and x-ray followed by operation, is of course not always successful, but certainly more so than any other method.

The case of epidermoid carcinoma reported was pathologically not a very malignant one and was operated on first and then treated with radium and x-ray as was thought best at that time. Fortunately, up to date no recurrence has been noted (Fig. 25).

This discussion of diseases of the jaws is based on actual cases treated and should therefore accentuate the importance of the remarks made in their connection. The main reason or excuse for reporting them is to preach and spread the gospel of conservatism. Good surgery is not radical.

DISCUSSION

*Dr. Armin Wald, New York City, N. Y.*—It was indeed a great pleasure to hear and see all that Dr. Blum so ably presented to us this evening and there is little that I can say, except in praise of his work and to ask you to think seriously on the point he stresses, namely that of good surgery.

When the essayist speaks of radical and conservative surgery and their relative merits, he really has in mind good surgery. When radical methods are imperative, he too is the advocate of them, and when conservative methods are indicated, the essayist, as we all, I am sure, would operate to conserve and restore.

In malignancy, radical operations in and about the mouth are beyond the field of the average oral surgeon and when these conditions progress to that stage where radical removal of all possibly infected tissue is imperative, I am sure that Dr. Blum will agree that it would be poor surgery to be conservative. On the other hand, to interfere in this manner in treating an osteomyelitis, that is, to remove radically all tissue that might possibly become infected would certainly end disastrously and be poor surgery. It is not surgery at all that leads the tyro to curette the dry socket, or to abuse the case of acute periostitis as described by Dr. Blum, and I doubt if anyone here present would advocate such procedure.

"Fools rush in where angels fear to tread." The importance of conservation of tissues of the mouth and the restoration of diseased tissues is the constant problem of the dentist and the oral surgeon.

The disfiguring results of radical surgery, the unsightly depressions so baffling to the art of the posthodontist can ofttimes be avoided by conservative operations which though less spectacular are most gratifying in results. Conservation of tissue is as important in the mouth as in any other part of the body and to ruthlessly destroy that which can be conserved is not practising good surgery. Radical or conservative, there can only be one kind of surgery and that is good surgery.

# A FEW MINUTES WITH THE NASAL ACCESSORY SINUSES*

By G. B. Trible, M.D., F.A.C.S., Washington, D. C.

IT IS evident, considering the nasal accessory air cells as a part of the upper respiratory tract, that they are subject to all inflammations that affect any other part of the tract. Every cold, every specific invasion of the nasal mucosa invades these contiguous air cells. The bacterial flora of the sinuses is the same as that of the nasal mucosa, the same laws hold for both and if no other factors entered, an acute rhinitis and an acute sinusitis would be synonymous.

They can be roughly divided into two groups, the one draining through the common channel under the anterior end of the middle turbinate and the other group discharging by separate openings into the posterior nares and down the posterior pharynx wall.

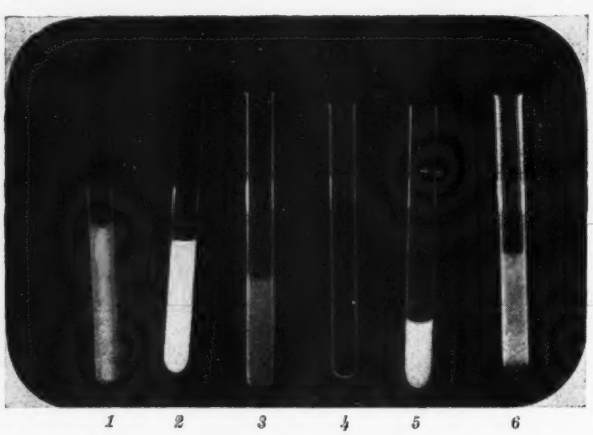


Fig. 1.—Various roentgen-opaque solutions. *1*, Iodipin, 50 per cent; *2*, Lipiodol, 33 per cent; *3*, Neosilvol, 30 per cent; *4*, Sluder Oil, clear; *5*, Argyrol, 20 per cent; *6*, Mercurochrome, 2 per cent.

The first group includes the maxillary antrum, the anterior ethmoidal cells and the frontal sinus, while the second group is composed of posterior ethmoidal cells and the sphenoid. The first group is the great meeting ground of the rhinologists and the dental surgeons, for it embraces the antrum which furnishes about one-half to two-thirds of all cases of sinus involvement requiring attention other than what would be given to the ordinary upper respiratory infections. With the antrum, a divergence from the other sinuses is shown in embryo and early childhood. The tooth buds, with the later cysts and other developmental defects they cause; and in after life, development of dental infections and those from the mouth, from which the nasal mucosa is spared, render a study incomplete without consideration of the oral and dental sides of the question.

*Read before the dental faculty of Georgetown Dental School, Georgetown University, April, 1928.

The present marked interest in sinus diseases has apparently brought to light an alarming state of affairs, but it is probably more apparent than real. In years gone by, these conditions were often classed as neuralgias, various types of headaches, incomplete tic douloureux, and in their ultimate, the patient succumbed to brain fever or some of the diseases in the vague nomenclature of a quarter of a century ago. The recent pandemic of streptococcal infections of the several strains may have left in their wake a tendency to upper respiratory complications.

The first attention of note in a surgical way, was drawn to the relationship of the antrum and the teeth by Cowper, who drained an antrum suppuration by extracting the canine. This must have been a case with a very well developed antrum extending down into the alveolar border, for ordinarily the second bicuspid and the first and second molars only are in contact with the antral floor. Infections of the antrum are naturally the

Fig. 2.—Complete filling of normal antrum.

Fig. 3.—Side view showing probable cyst, dome-shaped collection of lipiodol in the upper border of the antrum.

ones with which the dental surgeon is most frequently called into consultation first, and his contacts are made with the rhinologists in this field. A great deal of time, suffering and incidental inefficiency are saved the patient if a proper cooperation can be obtained.

Antrum conditions may rise, and do arise I feel, in about fifty per cent of cases from the teeth; not necessarily from dead teeth. They may rise from pyorrhea pockets around perfectly vital teeth, may arise from trauma in the extraction of teeth without any direct opening being made through the antral floor. A thrombophlebitis of the minute veins may be the pathway of the invading infection, the lymphatics may possibly be a factor, an apical abscess may have pushed up to the floor, or a cyst even raised the antral floor. The infection may have extended from an ordinary nasopharyngitis by continuity through the ostium, or it may have descended from the anterior ethmoidal cells, or the frontal sinus through the ostium into the antrum. Secretions may have accumulated, decomposed, eroded the superficial mucosa, may have been so tenacious or in such quantities that the

normal action of the cilia, which is from the periphery toward the ostium, could not be effective, and so an invasion may have taken place, which in turn has extended through the mucosa, created a periostitis, an osteitis, or an osteomyelitis, devitalized the teeth in contact with that area, interfering with their nutrition, dental apical abscesses may have formed and the same end-result been obtained, as though the infection had extended through the pulp into the bone through the apex.

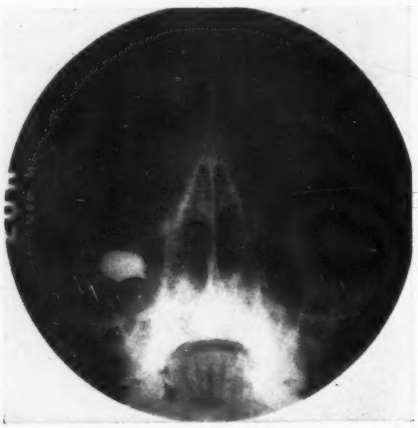

Fig. 4.—Nearly complete filling of antrum with inflammatory products. Chronic case of sinus infection of a plastic type.

Fig. 5.—Lateral view.

It is probable that the mere traumatic opening of the antrum during an extraction will not produce an infection if properly and quickly closed, unless there is already an existing disease of the mucosa or the deeper structures. For that reason it would appear advisable, in cases where such complications have arisen, to cleanse and suture the wounds, not to irrigate or to force foreign material into the antrum, but to give the natural reparative processes an opportunity to handle the situation. If on inspection, the antrum does appear diseased, we have recently put at our disposal a method of deter-

mining the approximate condition of the lining and walls of this cavity, which is probably of really more value than a casual inspection or even an exploration through the wound with a nasopharyngoscope, and that method is by the injection of lipiodol, which is roentgen-opaque, is nontoxic and possibly of some curative value in itself. Previous radiographs, of course, should have been taken and then the patient radiographed after filling the cavity with lipiodol. A comparison of the antrum outline and the existing cavity is of the greatest benefit, and determines the course to be pursued.

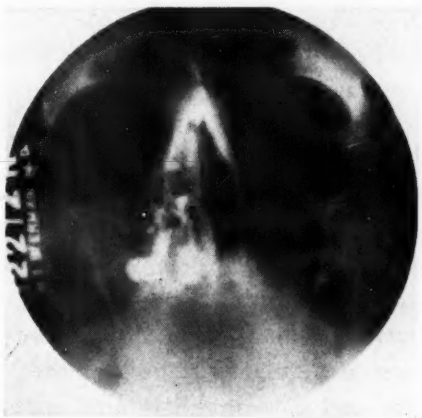

Fig. 6.—Nearly complete filling of the antrum with inflammatory products. Retort shape space only open, which is filled with lipiodol. A chronic case referred for consultation. He had been advised from simple vaccines to operative procedures. Rather extensive surgery would probably be necessary.

Fig. 7.—Injection of lipiodol through dental fistula. A small projection can be noticed in the illustration. Note large filling defects. A nonoperative case owing to the cardiovascular-renal changes.

Fig. 8.—Chronic infection around the roots of teeth with involvement of the anterior floor. Teeth have been extracted and the maxilla curetted, but the area of erosion in the anterior border has not cleared up. Should have an open operation.

Marked filling defects in the ethmoidal angle could be interpreted as an extension of the disease from above, the descending type of infection. The outer wall being widely separated from the opaque solution, or the presence of elevations and depressions above the alveolar margin would tend to throw the blame on the teeth or mouth as the causative factor. Cysts or neoplasms would be thrown into relief, and the early recognition of surgical

conditions not only be of value to the patient, but tend to the assistance of the dental surgeon and to his protection in cases where the tendency of the patient is to blame those infections on some dental surgery.

The question of surgical treatment of the antrum is a very pointed and as yet disputed one. The older school of surgeons and rhinologists favored an invasion of this sinus through a tooth socket with the idea of getting drainage from the most dependent part. If this were a good method, we would not have the fistulas leading into the antrum through the tooth sockets that we find today, nor would it have been supplanted by the most universal Luc-Caldwell, or some of its modifications. It is impossible mechanically to reach and remove all the infected mucosa and granulations through a dental opening or through an intranasal window. If permanent pathologic changes have taken place, an open operation is indicated.

As before mentioned, the antrum cannot be considered alone, except in those rare instances where it is perfectly normal and has been accidentally opened during surgical dentistry, and in these cases it will heal in nearly a hundred per cent by a simple clean closure of the wound.

Diseases of the superior maxilla differ from diseases affecting the long bones. The air-cell bearing bones of the skull are fundamentally flat bones, with no actual marrow cavity, with but a thin cortex, very prone to isolated areas of osteitis and osteomyelitis and with no protection except a thin mucosa.

Series of studies of the bone and membrane removed have been made and in practically every case the pathologic condition was the same—a subacute and chronic plastic process, resulting from long-standing infection, and in addition to the inflammatory changes in the mucosa, the periosteum is almost invariably thickened. There is usually marked destruction of the bone and in some few an evidence of an attempt at new bone formation.

The dental surgeon is helpless in the cases that really need surgery without the rhinologist, and the rhinologist in the case of dental origin is equally helpless without the dental surgeon. Their lack of cooperation is a standing reproach and is paid for by them in the loss of prestige and practice and unfortunately by the patient in his prolonged period of disability or partial invalidism.

# *ABSTRACT OF CURRENT LITERATURE*

**Covering Such Subjects as**

**ORTHODONTIA — ORAL SURGERY — SURGICAL ORTHODONTIA — DENTAL RADIOGRAPHY**

**It is the purpose of this JOURNAL to review so far as possible the most important literature as it appears in English and Foreign periodicals and to present it in abstract form. Authors are requested to send abstracts or reprints of their papers to the publishers.**

**Relation of the Acidophilus Bacillus to Caries.** R. W. Bunting and others (Ann Arbor). The Dental Cosmos, January, 1928, lxx, 1.

Although the bacteriologic factor in caries is often belittled the results of the authors' research are worthy of notice because in part of the amount of original work involved. The number of children studied in this connection was 1335, the ages being varied, and for whatever reason there was a close correlation between the presence or absence of caries and of the bacillus in qustion. As a result of two years of research the authors have become convinced that there is a necessary connection between the incidence of caries and the presence of the microorganism in question. This association supersedes in importance any clinical association of caries with a given factor—diet for example. To clinch any suspicions the authors found that caries ceased with the disappearance of the bacilli; while those who had been free from caries only to develop it later were found to have these organisms in the mouth after prior absence. Further points of contact were found in the diet and in the amount of dental care so that several factors are seen to cooperate in caries—diet, dental attention and the bacillus. The authors tested an antiseptic (metaphen) with the idea of inhibiting the growth of the bacillus but while there was much individual difference it was evident that the degree of inhibition was an important factor in control of caries.

**Torus Palatinus and Its Operative Treatment.** A. B. Crane (Washington). Dental Items of Interest, January, 1928, l, No. 1.

This affection is a deformity of the vault of the hard palate expressed as a prominence of the median raphe. In appearance it may vary from a slight ridge to an overhanging lobulated mass which may be further constricted in the middle with presentation of two distinct masses. Opinions differ as to the nature of this formation and possibly there may be different histologic types, of compact and spongy bone, respectively. The condition is hardly a true exostosis (Hrdlicka). The deformity while probably connected with the development of bone is seldom met with during adolescence and so slow and insidious is the growth that the dentist is often the first to notice it. At the other extreme, cases are encountered in which the patient is quick to note that something is wrong and to seek surgical aid. According to the experience of the dental profession about one patient in eight presents a

malformation of this type. Although usually slight, it is sometimes in the way when a full upper denture is to be constructed. This factor alone led the author to devise a technic for removal. Local anesthesia suffices and the first step is a suitable incision of wide extent especially to the rear. The periosteum is then elevated and the flaps turned back. The bone is removed in the rough with bone forceps and the completion of the work is left to the circular bone files of the dental engine. The suturing is then attended to and two weeks allowed for healing before any attempt is made to have an impression made or to resume the wear of an old denture.

**Relation of Focal Sepsis to Mental Disease.** Wm. Hunter (London). The American Dental Surgeon, January, 1928, xlviii, 1.

The author read this paper before the Section on Mental Diseases of the British Medical Association, session of 1927, and he stresses the fact that this is the first occasion in the history of this sectional activity in which the subject has been brought up, although as far back as 1900 the author was calling attention to the association of oral sepsis with neurasthenia, depressive states and nervous breakdowns. There was for many years no reaction to the author's views but in 1918 Cotton of the United States began to give attention to this possibility and in 1923 he read his paper before the Royal Medico-Psychological Society. Ever since this epoch there has been plenty of attention devoted to the subject and while there is some disagreement as to details it is almost wholly agreed that in all psychiatric patients attention should be devoted to the teeth and all anomalies and diseases corrected. After some remarks on dental sepsis in general the author gives cases of so-called septic psychosis from the practice of Cotton and others. Incidentally the rôle of impacted third molar in the genesis of psychoses is discussed. In Great Britain the first hospital to take up the problem has been the Rubery Hill and Hollymoor Mental Hospital of the Birmingham Corporation. Here it was readily shown that 76 per cent of the patients had oral sepsis, 40 per cent tonsillar sepsis, etc. Although somewhat lower than Cotton's figures they are none the less impressive. From now on we may feel assured that the interned psychotic will receive any benefit of the doubt as to whether his malady could be due to dental troubles.

**Ionization of Septic Roots.** C. F. Bödecker (New York). The Dental Cosmos, November, 1927, lxix, 11.

The author makes his report as Chairman of the Scientific Research Committee of the Dental Society of the State of New York. The number of infected roots ionized before extraction and then studied microscopically is still insufficient for the formation of a final judgment as to the possibilities of this means of sterilization. Experiments have shown that stains penetrate the tissues much more deeply when acted on by the electric current and these experiments therefore bear out the experiences of clinicians as to the benefits of ionization. Further investigation possibly also in animal experiment should be undertaken.

The report was discussed by the Society and Dr. Alfred Walker, who has practiced ionization for the past fifteen years, spoke of the previous neglect of laboratory research on the subject. We have only been able to check up improvement with roentgenograms, a fallacious resource because infected teeth may not photograph. The speaker recalled the dictum of Price who stated years ago that while ionization could sterilize a granuloma of the apex it did not affect infected dentin and he would like to know whether all parts of the teeth are reached; also, if sealing up the apical foramen would prevent disinfection of the periapical tissue. Dr. Bödecker in replying stated that the current traverses the dentin which is in the path of least resistance and added that in his experiments all of the apical foramina were sealed.

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# *EDITORIALS*

## The Code of Ethics of the American Dental Association

THE Code of Ethics of the American Dental Association as adopted at the meeting held in Detroit in October, 1927, contains many things that are of interest to the specialist. Owing to the rapidity with which different groups of specialists have appeared in the dental profession, it evidently was thought necessary to adopt some rules for governing their conduct. These rules, written from an ethical standpoint, also have a greater bearing from a legal standpoint than at first might be imagined.

Section II of the Code of Ethics deals with advertising and lays down certain rules for conduct of the members of the American Dental Association. It still leaves open the disputed question as to when advertising is not advertising. It has become customary for some men to limit their practice to

a certain specialty and to have that specialty printed on their letterheads, cards, and even envelopes. While it might be permissible to have "Practice limited to Orthodontia" printed on letterheads or cards, we fail to see how such information printed on the envelopes is going to be of any assistance to the Postal authorities. Certainly "Dr. Paul Jones, Orthodontist, Athol, Missouri" is going to be of no assistance to the Postoffice if this letter is returned to "Dr. Jones." While the American Dental Association does not prohibit such practice, nevertheless, we believe it could have added that "This association believes such custom to be unbecoming to its members and suggests that members abstain from such practice."

Section III deals with directory announcements which should be very carefully studied by men at the present time. While the conduct of dentists in regard to city, commercial, telephone and other public directories is very clearly outlined, it still leaves open the question of professional directories. For a number of years, Polk's Dental Directory has been published. It is supposed to be a professional directory. However, any dentist who subscribes to the directory has his name inserted in large letters with as much of a biography as he desires to supply. The publishers of the directory actually supposed each subscriber was entitled to this extra space and attention. In times past practically all men submitted to this special privilege. In fact, it had become so customary for the publishers to grant this special attention to the subscribers that it was quite difficult for a subscriber to get his name inserted without the publishers putting his biography in also. The publishers have been so insistent that special request has to be made by subscribers in order to keep the name from being inserted in large type. Such a request was made prior to the publication of a recent edition, but in spite of that, the name appeared in large type. While the Code of Ethics of the American Dental Association does not mention professional directories, we believe the dental profession should follow the plan of the medical profession and all names should be published in the same type.

Section IV considers the advisability of professional men inserting cards in local papers, and states that if the dentist confines himself to a specialty, he may be permitted to announce in modest type "Practice limited to ———," announcing the specialty but nothing more. Section IV also contains the following admonition, "This Association, however, believes such custom to be unbecoming to professional men and urges its men to abstain from such practice."

Section V deals with the use of professional cards, letterheads or announcements giving the name, title, address, telephone number, and office hours; and if he confines his practice to a specialty he may so announce it.

You will notice in both these sections, the word "specialist" has been eliminated from cards, letterheads, or announcements, or from printing on entrance doors or windows. The sections use the phrase "Practice limited to ————" but do not state why it should be used instead of stating that the man is a specialist. The question as to whether a man limits his practice to orthodontia or advertises himself as an orthodontist is not so much an ethical problem as it is a legal question. The man who calls himself an

orthodontist, oral surgeon or specialist, assumes a greater legal responsibility than if he limits his practice to orthodontia, oral surgery, etc. A man who poses as a specialist, as an orthodontist or oral surgeon announces to the world that he is a man of greater skill and consequently he is expected to produce more than ordinary results. If a specialist displays only the usual amount of skill in handling a case, he may be held liable; but if his practice is "limited to oral surgery," he does not claim to have unusual skill, but simply states that he is doing no other kind of work. The same applies to the orthodontist. While the Code of Ethics does not mention the legal phase, however, in this day of numerous damage suits, it is wise for men to have printed on their cards, letterheads and doors, the words "Practice limited to Orthodontia" rather than "Orthodontist."

It should be remembered that a Code of Ethics is based upon the growth and education of the profession, and what may seem to be complete at the present time, may be insufficient as conditions change. However, the present Code of Ethics of the American Dental Association is as complete as can be under the existing circumstances. We would suggest that every reader of this Journal familiarize himself with the Code of Ethics as adopted by the American Dental Association.

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## New York Society of Orthodontists

THE Annual Meeting of the New York Society of Orthodontists was held at the Hotel Commodore on March 14, 1928. This was one of the largest attended meetings in the history of the Society.

The following scientific program was presented:

Gleanings from the members of the January conference conducted by the New York Society of Orthodontists, under the direction of Dr. Mershon and his assistants. (a) Dr. A. E. Howes. (b) Table Clinics and demonstrations by selected members of the class, reviewing principles of technic on anchor band construction, attachments, lock wires, stabilizers, lingual and labial arches, and auxiliary springs as described by Dr. Mershon. (c) Adjustment of auxiliary springs and summary.

Motion Picture, *Glimpses of the Members at the 1927 Meeting of the American Society of Orthodontists.* Taken by Dr. David B. Hill, Salem, Oregon.

*Concerning Organs Affecting the Eruption of Human Teeth* by Charles F. Bodecker, D.D.S., Columbia University (by invitation). Formal discussion by Lawrence W. Baker, D.M.D., Harvard University.

*The Jaw Bones in Malpositions of Teeth During Tooth Movement and Retention* by Egon Neustadt, M.u.D., New York University (by invitation). Formal discussion by Dr. Martin Dewey.

Case Report, by R. L. Webster, D.M.D., Providence.

The summary of the course given by Dr. Mershon and his assistants as presented by Dr. A. E. Howes received very favorable comment. It was a very good presentation of Mershon's orthodontic teachings. The clinics which followed, given by different men, were very well attended.

A great amount of interest was shown in the motion picture of the members of the American Society of Orthodontists at the 1927 meeting. The Society is indebted to Dr. Hill for arranging to have this picture shown.

Dr. Bodecker's paper was based on Dr. Isak Robinsohn's theories. While these theories are very interesting there are still many things which they failed to explain and many statements which cannot be substantiated at the present time; all of which was recognized by Dr. Bodecker.

Dr. Neustadt's paper was the result of research which Dr. Neustadt has been carrying on for some time. The microphotographs were very well made and the subject of bone development was ably treated. The greatest difficulty of carrying on research of this kind is in securing proper specimens. Dr. Neustadt's work will be greatly aided if any members of the orthodontic profession who have anatomic specimens showing malpositions of the teeth, would forward them to him for study and investigation.

The case report by Dr. Webster was extremely instructive.

After the dinner Dr. Leuman Waugh gave an interesting account of his cruise in Labrador. Dr. Waugh has collected considerable data and his findings will be of great scientific importance in years to come. The time was too short for a complete presentation of the subject, and we hope that at some future time, Dr. Waugh will favor the Society with a scientific analysis of his investigations.

During the business session of the meeting, part of the Constitution dealing with active memberships was amended to read as follows: "Active members. No person shall be eligible to active membership, except those engaged in the exclusive practice of Orthodontia for a period of not less than two years." The qualification for active membership in the New York Society of Orthodontists is now the same as in the American Society of Orthodontists with the exception that the American Society of Orthodontists requires that a man be in active practice for three years before he can be elected to active membership.

At the request of the Board of Censors the following resolution was unanimously adopted, "All endorsers of applications for membership must send either to the Secretary or to the Board of Censors a letter regarding the application which they endorse, and said letter must be sent within the interim of one meeting" The adoption of this resolution became necessary because the Society is growing so fast, and over such a wide territory. The membership of the New York Society of Orthodontists includes the New England states, the Middle Atlantic states as far south as Maryland and the District of Columbia.

The Board of Censors had found in times past that many men had endorsed applications for membership without knowing much about the applicant. It would later develop that when the Board of Censors would investigate the application, the signer would invariably say, "I signed this because he asked me to. I do not know anything about him." Such a system has thrust a large amount of responsibility upon the Board of Censors and has made it quite difficult for them to investigate applications for membership as they should. It is believed the above-mentioned standing resolution will elimi-

nate a great amount of trouble encountered heretofore. It was remarked by some member of the Society that a similar standing resolution would be a benefit to the American Society of Orthodontists, and a great aid to the Board of Censors of that Society in passing upon applications for membership.

The New York Society of Orthodontists now has 125 members, 15 new members having been elected at the last annual meeting. The attendance at all the meetings was unusually large and is quite a compliment to the Executive Committee who has during the past year, endeavored to present attractive programs.

—*W. C. F.*

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**Erratum**

In the March issue of the Journal, page 233, the article by Dr. Cohen entitled, "A Review of the Recent Literature Pertaining to Rickets," was not read at the 39th Annual Meeting of the American Pediatric Society, Washington, D. C., May 12, 1927. This footnote was inserted through error.